Remote Sensing Procurement Package

A Technical Guide For State and Local Governments

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THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Remote Sensing Applications Program
Office of Space and Terrestrial Applications

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PREFACE

City, county and state governments are faced with the need to procure remote sensing products and services at acceptable risks and costs. To help local and state government overcome difficulties associated with remote sensing procurements Public Technology, Inc. (PTI) has prepared The Remote Sensing Procurement Package. This package has been designed to provide a methodology which officials can use to specify how remote sensing can meet their needs, select the most appropriate remote sensing technology or service, define the requirements of that technology or service, solicit and evaluate bids, and award and administer the contract. The development of this package has been financed by the National Aeronautics and Space Administration (NASA), Regional Remote Sensing Applications Program.

The Remote Sensing Procurement Package consists of four documents:

- Remote Sensing Procurement: An Executive Summary -- A short brochure written for elected officials and chief executives, that discusses the benefits of a structured remote sensing procurement process and describes the package organization, content, and scope.

- Remote Sensing Procurement: A Management Report for State and Local Governments -- A somewhat longer document, written for chief executives and senior administrators, that presents an overview of the remote sensing procurement process and explains how to plan, organize, staff, and implement a remote sensing procurement project.

- Remote Sensing Procurement: A Technical Guide for State and Local Governments -- A step-by-step procedural guide to the tools and techniques of remote sensing procurement, written for administrators, information managers, planners, and procurement specialists who will be directly involved in evaluating bids or proposals; negotiating, awarding, and administering a contract; or evaluating remote sensing procurements.

- Remote Sensing Procurement: The Remote Sensing Industry Directory -- A directory of over 140 firms and organizations which contains detailed information in the types of products, services and equipment which they offer. Also included for each firm or organization are addresses, phone numbers, contact person(s), and experience in the remote sensing field.

State and local government officials should address inquiries concerning this Package to:

- Remote Sensing
  Public Technology, Inc.
  1301 Pennsylvania Ave. N.W.
  Washington D.C. 20004
  (202) 626-2400

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The Remote Sensing Procurement Package was based upon earlier research financed by the Division of Intergovernmental Science and Public Technology of the National Science Foundation. The product of this research was a document entitled Nonstandard Procurement: A Technical Guide for State and Local Governments. The Nonstandard

Procurement document was prepared by PTI's Technology Exchange Program which was managed by C. Nelson Hoy. PTI staff members responsible for the Nonstandard Procurement Technical Guide are Bruce Steinthal, Project Director; Kenneth M. Steil, Analyst; Marcia House, Editor; Walter Webb, Information Specialist.

The Remote Sensing Procurement Package was produced by PTI's Decision Support Systems Program, managed by Jack Barrett. The documentation was compiled and prepared by Cynthia Kahan, Research Associate, under the direction of Matthew Jaro, Project Manager. The project was conceived by Peter Buckman, former Project Manager. David Brooks served as Technical Consultant.

INTRODUCTION

This Technical Guide provides the tools and techniques for procuring remote sensing products and services. It is written for administrators, procurement officials and line agency staff who will be directly involved in identifying information needs; defining remote sensing project requirements; soliciting and evaluating contract responses and negotiating, awarding, and administering contracts. The Technical Guide is part of a package of tools designed to assist local and state governments. The complete package consists of four parts: An Executive Summary, A Management Report, The Technical Guide, and a Remote Sensing Industry Directory.

POTENTIAL BENEFITS

The step-by-step process described in this Technical Guide offers several potential benefits to state and local governments engaged in Remote Sensing Procurements.

- o A more thorough investigation of the problem and alternative solutions, enables elected officials, chief executives, and senior administrators to better assess staff recommendations;
- o Greater opportunities for interaction between the chief executive's office, user, procurement agency, and other affected agencies enable analysts, technical experts, and other staff or line personnel to shape requirements and evaluation criteria so that the resulting remote sensing product or service more closely conforms to their needs and constraints.
- o Improved requirements and evaluation criteria simplify the selection of a contractor and administration of the contract;
- o Greater understanding of the need, requirements, and capabilities of various firms, coupled with the increased contract administration efforts, results in the timely acquisition of more effective and efficient remote sensing products and services for the public's tax dollar; and

- Increased structure in the procurement process enables top management to better judge staff performance.

SCOPE AND FOCUS OF THE GUIDE

In general terms, remote sensing is a method for obtaining and recording information without coming into direct contact with the particular object or area being investigated. This Guide will focus upon remote sensing systems with the widest potential for application by local and state jurisdictions. These include cameras and sensors mounted in aircraft or satellites and operating in the visible, near infrared, thermal infrared and microwave portions of the electromagnetic spectrum. Typical remote sensing products covered by this Guide include conventional low and high altitude panchromatic, color, and color infrared photography, satellite data products including both imagery and digital records, and side looking radar (SLAR) and thermal infrared imagery. Of course all these primary products are subject to various processing, enhancement, and analysis methods yielding a variety of photographic images, topographic, planimetric, and thematic maps, computer generated graphic displays, and statistical summaries.

Remote sensing techniques are widely used by local and state governments to gather data for a variety of purposes. These include among others the detection, identification, measurement, and monitoring of urban land uses, natural resources, geologic features, agricultural and natural vegetation and environmental quality. Aerial photography is the oldest and most commonly used remote sensing technique. However, the field has expanded rapidly, with the introduction of sensors capable of obtaining information in a wide range

of the electromagnetic spectrum; satelites such as LANDSAT which are solely devoted to the collection of earth resources data; and computer software and hardware which can analyze an incredible volume of remote sensing data both efficiently and rapidly. These latter developments have revolutionized the field of remote sensing. Figure I illustrates a typical remote sensing system which incorporates these newer techniques.

Unfortunately the benefits of these newer developments have not been fully utilized by state and local governments. There are many reasons for this. Local and state officials may simply lack knowledge, training, or experience with the uses and benefits of rapidly changing remote sensing techniques. However, once such knowledge has been obtained, other factors may operate to make the actual procurement of remote sensing products and services unlikely or difficult. Some of these factors are listed below:

- Management may not have a method for recognizing and assessing the appropriate role of remotely sensed data in meeting a variety of information needs;
- Management may have difficulty assessing the value of remotely sensed data to operations and decision making;
- Procurement personnel may be unsure how to develop specifications for remote sensing procurements because each jurisdiction's requirements are often unique or unusual.
- It may be difficult to evaluate the trade offs between cost and technical considerations especially with the more complex or innovative remote sensing systems;
- The jurisdiction may be forced to solicit responses from firms located outside its geographic area in order to obtain a sufficient number of bids or proposals;

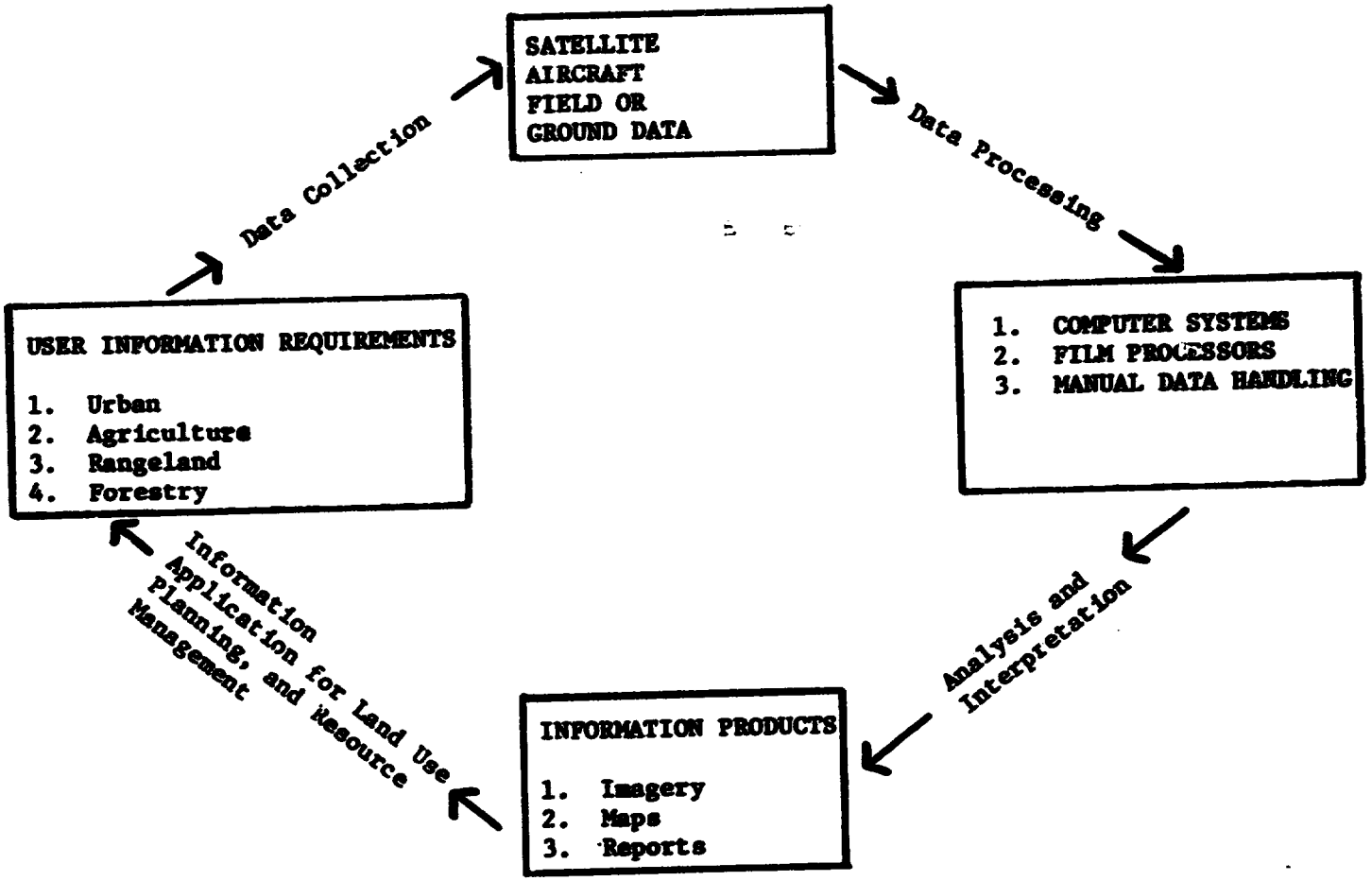

FIGURE 1 -- REMOTE SENSING SYSTEM

Source: Practicing Planner magazine, Volume 6, No. 5, December, 1976, pp. 21. (a publication of the American Planning Association, Washington, D.C.)

- o Complex or costly Remote Sensing procurements may require the use of negotiations on other procurement strategies not commonly used;
- o Careful contract administration may be required to avoid cost overruns and delays;
- o A post-procurement evaluation may be needed to determine the actual effect and success to the procurement;

These potential procurement related problems are the focus of this Guide. Through a series of tasks and steps the user of this Guide is guided through the procurement process. In general a detailed discussion of Remote Sensing Technology, applications and Products is beyond the scope of this document. Individuals unfamiliar with remote sensing may want to supplement this package with other references listed throughout the Guide and Appendices. However, a successful procurement does not require that the personnel involved acquire extensive technical expertise. This Guide will stress that it is more important in developing a successful RFP or RFB to accurately and precisely define the information requirements and the desired capabilities of the remote sensor system rather than specify the technical components in great detail.

ORGANIZATIONAL REQUIREMENTS

This Technical Guide presents the procurement process in a project management framework. The process recommends the formation of a temporary procurement team for the explicit purpose of purchasing a remote sensing product or service. The team should consist of one or more people with the following perspectives:

- o A broad management perspective
- o A user perspective
- o A purchasing perspective
- o Appropriate technical perspectives.

The procurement team members, their responsibilities and the qualifications are described in the accompanying management report as well as in Section I, Task II of this Guide.

RECOMMENDED STRATEGY

A remote sensing procurement project should involve the same six phases described in most standard purchasing texts. The differences between purchasing standard and remote sensing items are in the significance of the various tasks involved in each phase, and in the procurement strategies and techniques employed in each task. The six phases are:

- o Need Identification,
- o Preparing Specifications and Evaluation Criteria,
- o Bid or Proposal Solicitation,
- o Bid or Proposal Evaluation,
- o Contract Negotiation and Award, and
- o Contract Administration.

This Technical Guide expands these six phases into a series of tasks and steps. Each task represents a concern that must be addressed if remote sensing procurements are to be successful. This does not, however, mean that a procurement team must follow every step documented in this Guide for the procurement to succeed. Remote sensing procurements vary in size, significance and complexity, and many may not warrant the execution of each step all the time. Nevertheless, the basic objectives of each task must be recognized and accomplished. Toward this end, the Guide describes alternative levels of effort for as many of the steps as possible. Figure 2 illustrates the remote sensing procurement process in its entirety.

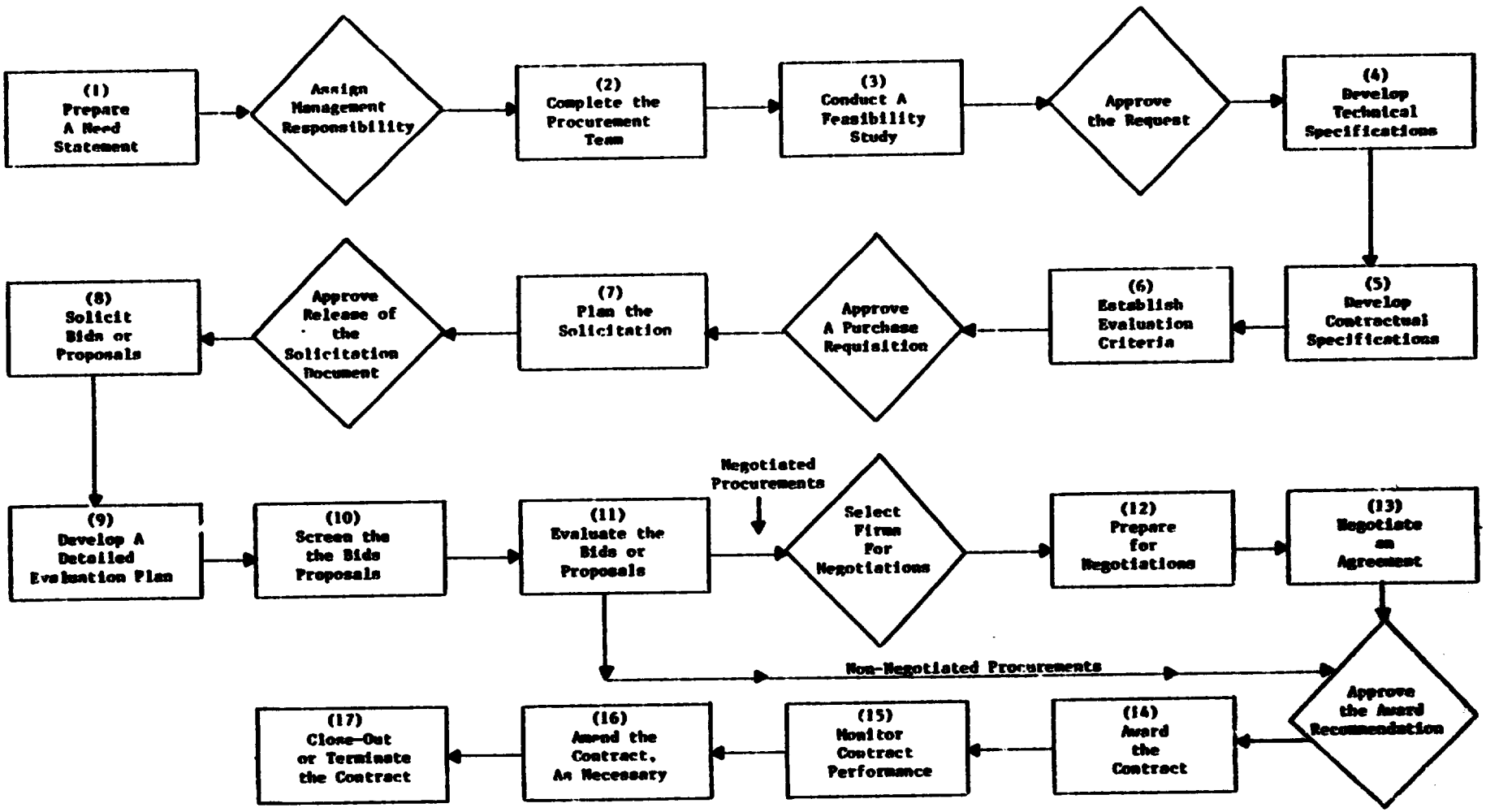

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FIGURE 2 -- Remote Sensing Procurement Process

This diagram summarizes the 17 major tasks and six management approval points in the Remote Sensing Procurement Process. Top management can abort the procurement at any of the six decision points. The diagram does not attempt to show any feedback loops in this process.

The first phase -- Need Identification -- ensures that the requested product or service is actually necessary and feasible. The budgeting process, with its emphasis on the ability to afford procurement requests, often overlooks questions relating to need, alternatives, and benefits. The three tasks in this phase involve developing a need statement, organizing the procurement team, and conducting a feasibility study.

The second phase -- Preparing Specifications and Evaluation Criteria -- produces a firm, unambiguous statement of the requirements that the remote sensing product or service must meet to successfully resolve the stated need. Vague, uncertain, or uninformative requirements will usually generate ambiguous bids or proposals and costly, midstream changes to the contracted scope-of-work. The three tasks in this phase involve developing contractual requirements, and establishing evaluation criteria.

The third phase -- Bid or Proposal Lolicitation -- generates offers from interested firms. A sufficient number of offers from qualified firms are needed to ensure competition from both price and performance perspectives. The two tasks in this phase involve developing the solicitation document and soliciting bids or proposals; the solicitation document establishes a procurement strategy and includes procedures for handling inquiries and amendments.

The fourth phase -- Bid or Proposal Evaluation -- develops an award recommendation. This evaluation is designed to identify the one or more contractors best able to satisfy the requirements of the procure-

ment. The three tasks in this phase involved preparing the evaluators, screening the bids or proposals (i.e., eliminating unacceptable ones from detailed consideration), and evaluting the (acceptable) bids or proposals.

The fifth phase -- Contract Negotiation and Award -- results in a signed contract between the jurisdiction and one firm. Negotiations may be necessary to clarify or modify specific aspects of a proposals, to select one offeror from among several that have been recommended, or to reach an agreement on price or other business aspects. Even when negotiations are not required, an agreement must still be translated into a contract. The three tasks in this phase involve preparing for the negotiations, negotiating an agreement, and awarding the contract; the preparations involve formulating negotiating objectives, selecting and briefing the negotiators, determining relative bargaining positions, selecting a time and place, and preparing a meeting agenda.

The sixth and final phase -- Contract Administration -- ensures that the contract deliverables are of acceptable quality, and that the contract is performed on schedule and without cost overruns. Non-standard products and services, by their very nature, generate more contractural changes and problems than do standard items. The three tasks in this phase involve monitoring contract performance, amending the contract when necessary and closing-out or terminating the contract.

SECTION I -- NEED IDENTIFICATION

A procurement process for remote sensing products, services or equipment begins with the perception that remote sensing can fill a need for information. The need should be documented in a Needs Statement which describes the information problem and proposed solution so that the appropriate decision-maker can determine whether the suggestions merit further consideration. The Needs Statement is important because this is the vehicle through which the proposal is formally carried and logically presented to the appropriate level of management, and it represents a justification for the work to be performed. If the Needs Statement can establish that there is a sufficient and compelling requirement for the data, and that the information is not currently available or available only at great cost in time, manpower, or money, then a decision-maker can appoint someone to study the feasibility of the remote sensing procurement prior to reaching a final determination regarding acquisition. Thus, the procurement procedures described in this Section are designed to produce a Needs Statement which will:

- Inform top management about the information need in a detailed and specific fashion.
- Propose a possible solution or range of solutions to resolve the information problem.
- Enable top management to decide if further consideration is warranted in the form of a feasibility study.

TASK 1 -- DEVELOP A NEEDS STATEMENT

The correct approach for the development of a Needs Statement is to clearly define the need or problem, examine the potential benefits to the users of the information, and provide a justification for proposed remote sensing procurement. The Needs Statement is best developed in seven steps:

1. Describe the information problem or need.
2. Identify other organizations with similar needs.
3. Define multiple information needs.
4. Identify potential information solutions.
5. Estimate costs and benefits.
6. Develop a work plan.
7. Report the results.

Step 1: Describe the Information Problem

The first step in preparing a Needs Statement is to clearly define the information need or problem and to determine the importance or value of obtaining better information. This step is often overlooked, especially when the needs seems obvious. However, experience has shown that initial perceptions are often vague, incomplete, or misleading.

The proponent of the procurement should begin describing the information need by defining the goals and objectives of the affected program. The proponent should then describe the ideal information requirements which would enable program goals and objectives to be met. This will ensure that the Needs Statement responds to a positive

set of requirements rather than a negative set. Next, a list should be generated which summarizes the types and sources of information that are presently available and being used to do the prescribed work. Finally, the existing information and the ideal information requirements should be compared in order to highlight the deficiencies that are present in the existing data base.

Table I-1 suggests several characteristics and associated questions that should be considered when evaluating information needs. These characteristics have been emphasized because they will be useful later in matching a remote sensing solution to the perceived data collection and interpretation problem.

It is very important at the conclusion of this step to also assess the importance of resolving the information need by describing how additional information or improvements in the quality of existing information will make the program more effective in achieving goals and objectives. The proponent should determine if solving the information problem is essential, desirable, or unessential to meeting program goals and objectives. This assessment should be specific and quantified if possible. Thus, Step 1 should contain the following ideas:

1. A description of program goals and objectives;
2. A description of the various types of information needed to meet program goals and objectives (ideal information requirements);
3. A description of information which is needed but not currently available;
4. An analysis of the information need in terms of the specific characteristics outlined in this step (scale, timeliness, area of coverage, etc.);

TABLE I-1 -- INFORMATION CHARACTERISTICS

Area of Coverage -- What area will the data cover? Relate the data to the geographic area where the information is to be gathered, i.e., statewide, county level, metropolitan, sub-metropolitan.

Time Frame of Coverage -- How frequently are the data to be collected: Are the data to be gathered continuously (i.e., air quality monitoring) or seasonally (i.e., crop identification): Specify the time of year and length of time the data are gathered.

Detail, Scale Required -- What level of detail is required of the data? If the information is normally available in a map format, specify the appropriate scale needed. How minute and distinct must the information be?

Timeliness -- How soon is the information available after it has been gathered? Information on rapidly changing conditions/situations must be available immediately to be useful. Slower changing conditions such as soil type, geologic formations will not require immediate availability.

Update Frequency -- How frequently must the data be updated? An assessment of how often the information must be gathered in order to accurately reflect changing conditions and meet programming and planning requirements is important.

Reliability -- How important is it that the data gathering methods produce the same results on successive trials?

Accuracy -- How free from error must the data or information be? How much error of commission or omission can be tolerated in the information before it compromises programmatic effectiveness?

Table I-1 (continued)

Format -- What display formats are best suited to the data? Information can be displayed in charts, graphs, tables, maps, and other graphic forms. What formats are most effective in displaying the various types of information used by your agency?

Interface Requirements -- Is the information gathered or used by your agency currently shared or used for other purposes, or by other organizational units. Is it in a form which can be readily used by other agencies or included in computerized data bases such as DIME files (geocoded data bases)?

Flexibility -- Is the maximum amount of information extracted from current data bases? Can current data bases be manipulated to provide information for a variety of uses?

Sensitivity -- Do your information needs require that the data be capable of reflecting minute differences?

Regulatory Constraints -- Are there local, state, or federal regulations or mandatory data requirements which influence your data collection practices?

5. The sources of existing information; and

6. A specific assessment of the significance of the information problem and the value of better information.

Step 2: Identify Other Organizations With Similar Needs

The value and likelihood of procuring specific remote sensing products will be greatly enhanced if they can be linked to the needs of other programs, departments, agencies, or jurisdictions. There are many benefits to this approach since multiple uses or users will increase the justification for a single procurement effort.

Fortunately, remote sensing lends itself to this type of sharing since data for basically unrelated applications can be extracted from the same data base. For example, the same imagery could be used for obtaining an overview of a region, making base maps, for land use planning and mapping, and for monitoring a wide range of environmental phenomena. Therefore, every effort should be made to demonstrate that cost savings will result from greater coordination between programs that share a common data base, that information exchange is more likely, or that other users may be willing to cost share all or part of the procurement.

Other organizations with similar information requirements may include:

- o Agencies operating within shared geographic areas.
- o Agencies with similar functional or programmatic interests.
- o Organizations that conduct research or have an information dissemination function.
  - Universities

- Non-profit institutes
- Federal/State/Local information or data collection agencies

o Private Industry
- Engineering, planning and environmental consulting firms
- Banks
- Utility companies
- Corporations with large land holdings

Step 3 -- Define Multiple Information Needs

The same precision used in defining the information need of the proponent should also be applied to the list of organizations identified in the previous step. These organizations should be contacted and their information needs systematically described and assessed according to the same procedures developed in Step 1. The relevant data to be gathered for each agency should include the same information gathered in Step 1.

o A brief description of program goals and objectives.

o A description of the various types of information needed to meet program goals and objectives (ideal information requirements).

o A description of information which is needed but not currently available.

o An analysis of the information need in terms of the specific characteristics discussed in Step 1 (scale, timeliness, area, etc.)

o The sources of existing information.

o A specific assessment of the significance of the information problem and the value of better information.

The individual or individuals preparing the Needs Statement should then compile and analyze the results of these contacts with other organizations in order to discover any commonalities in the information problems. The proponent should also determine if there are any existing data used by other organizations which are available and acceptably meet his information need, thus obviating the necessity of a procurement.

Step 4 -- Identify Potential Information Solutions

The objectives of this step is to identify a remote sensing solution or range of potential solutions to the information problem. Depending upon the specific nature of the information need, the proponent may also consider non-remote sensing information sources as potential solutions.

There are four primary sources which should be contacted to obtain assistance in identifying a solution:

- o Other jurisdictions.
- o Organizations with remote sensing expertise.
- o Published sources (journals, texts, and conference proceedings).
- o The Remote Sensing Industry Directory (included as part of this procurement package).

Table I-2 contains the names and addresses of government agencies and other organizations to contact for information and assistance. Table I-3 is a list of journals, manuals, texts, and bibliographic indices from which useful references can be extracted. These sources can be used to assist in identifying and characterizing the

TABLE I-2 -- SOURCES OF REMOTE SENSING DATA AND/OR TECHNICAL ASSISTANCE

FEDERAL*

For Information On:	Contact:
Landsat Satellite Data	National Aeronautics & Space Administration (NASA) Regional Applications Centers (for Landsat data use assistance)
	(Northeastern, Middle Atlantic, and Great Lakes States)
	Dr. Philip Gressy, Head Eastern Regional Remote Sensing Applications Center NASA/Goddard Space Flight Center Greenbelt, Maryland 20771 (301) 982-3658
	(Southern and Midwestern States)
	D. Wayne Moonehan, Director Earth Resources Laboratory National Space Technology Laboratories NSTL Station, Mississippi 39529 (601) 688-3326
	(Western States)
	Dr. Dale Lumb, Chief Technology Applications Branch NASA/Ames Research Center Mailstop 242-4 Moffett Field, California 94035 (415) 965-5900, ext. 5897
	United States Geographic Survey
	EROS Data Center (EDC) U.S. Geographical Survey Sioux Falls, South Dakota 57198 (605) 594-6511
	National Cartographic Information Center (NCIC) U.S. Geological Survey 507 National Center, Stop 507 Reston, Virginia 22092 (703) 860-6045

Table I-2 (continued)

Federal (continued)	
Operational Meteorological Satellite Data	National Oceanic & Atmospheric Administration (NOAA), Satellite Data Services Branch World Weather Building, Room 100 Washington, D.C. 20233 (202) 763-8111
Experimental Satellite Missions -- Seasat, Heat Capacity Mapping Mission (HCMM), Nimbus Coastal Zone Color Scanner (CZCS)	User Requirements & Assistance Space Applications Branch NASA Office of Space & Terrestrial Applications Washington, D.C. 20546 (202) 755-7450
Aerial Images	USGS EROS Data Center (see address above) USGS National Cartographic Information Center (see address above) Agriculture Stabilization & Conservation Service Aerial Photography Field Office Administrative Services Division ASCS-USDA 2505 Parley's Way Salt Lake City, Utah 84109 (801) 524-5856 U.S. Forest Service Engineering Staff Unit Washington, D.C. 20250
UNIVERSITY, STATE, AND PUBLIC INTEREST GROUPS	
Aerial & Satellite Remote Sensing	Universities with remote sensing programs (see Appendix A-2) State Remote Sensing Coordinators (See Appendix A-3 for names and addresses)

Table I-2 (continued)

University, State, and Public Interest Groups (continued)

Matt Jaro, Project Manager
Public Technology, Inc.
1301 Pennsylvania Ave. N.W.
Washington D.C. 20004
(202) 626-2400

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Earth Resources Data Project
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444 North Capitol Street, N.W.
Washington, D.C. 20001
(202) 624-5386

Paul Tessar, Senior Project Manager
Natural Resource Information Systems
National Conference of State Legislators
1125 17th Street, Suite 1500
Denver, Colorado 80202
(303) 623-6600

*For additional information on Federal organizations see Appendix A-1

TABLE I-3 -- SELECTED PUBLISHED SOURCES OF INFORMATION ON REMOTE SENSING

ABSTRACTS AND BIBLIOGRAPHIES

NASA Earth Resources Survey Program Weekly Abstracts

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
(703) 557-4650
$45.00 per year

Quarterly Literature Review of the Remote Sensing of Natural Resources

Technology Applications Center (TAC)
University of New Mexico
Alburquerque, New Mexico 87131
$50.00 per year

NASA Scientific and Aerospace Reports (STAR)

U.S. Government Printing Office
Washington, D.C. 20402
(202) 783-3238
$66.90 per year

JOURNALS

Photogrammetric Engineering and Remote Sensing (monthly)

American Society of Photogrammetry
105 North Virginia Avenue
Falls Church, Virginia 22046

Remote Sensing of the Environment (quarterly)

American Elsevier Publishing Company, Inc.
52 Vanderbilt Avenue
New York, New York 10017

MANUALS, TEXTS, DOCUMENTS

Manual of Photogrammetry, 4th Edition, 2 Vols., 1980

Manual of Color Aerial Photography, 1968

Table I-3 (continued)

Manuals, Texts, Documents (continued)

Manual of Photographic Interpretation, 1960

Manual of Remote Sensing, 2 Vols., 1975

For information on obtaining copies:

American Society of Photogrammetry
105 North Virginia Avenue
Falls Church, Virginia 22046
(703) 534-6617

A Land Use Classification System for Use with Remote Sensing Data, 1976, by J. R. Andersen, et. al. (USGS Professional Paper 964).

USGS National Center
Reston, Virginia
Available from USGPO*

Remote Sensing Application Guide, 1979 (EP 70-1-1)

Department of Army Office
Chief of Engineers
Washington, D.C. 20314
(202) 272-0257, 0258
Available from USGPO*, Stock # S-N0008-022-00150-6

A Guide to Obtaining Information from the USGS 1979 (Geological Survey Circular 777)

Branch of Distribution
U.S. Geological Survey
1200 South Eads Street
Arlington, Virginia 22202
(703) 557-2781

User Guide for Acquisition of Remotely Sensed Data and Support Services (Contract # NAS5-25364)

Prepared by G.E. for:

NASA, Goddard Space Flight Center
Greenbelt, Maryland 20771

Table I-3 (continued)

Manuals, Texts, Documents (continued)

Earth Resources Satellite Data Applications Series: Guide to Publication, Module U-1, January 1980

Regional Remote Sensing Applications Program
NASA, Office of Space and Terrestrial Applications
Washington, D.C. 20546
(202) 755-7450

*For copies of documents available from USGPO contact:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
(202) 783-3238

various remote sensing technologies in terms of their capabilities, costs, and availability.

Jurisdictions can learn a great deal about how to solve their problems by examining the actions taken by other jurisdictions under similar circumstances. Government practitioners in nearby jurisdictions should be questioned in the course of developing the Needs Statement. Information should also be sought on what leading-edge jurisdictions are doing. This information can be obtained by contacting:

- State Municipal Leagues
- State Departments of Local Government or Community Affairs
- State Managers' Associations
- State or Regional Innovation Groups
- National Public Interest Groups
- National Professional Associations

There are many private companies and government organizations which have expertise in remote sensing. They can provide information on various remote sensing systems and their applications. Many of these organizations also provide training programs, technical assistance and demonstration programs. In addition, some maintain archives of existing imagery or can assist in locating existing imagery in other federal and state agencies.

After contacting the above sources, an information solution should be described. This description should emphasize the characteristics of the R.S. product or service needed to resolve the information problem. The original list of information requirements described in Steps 1 and 3 (scale, time frame, area of coverage, timeli-

ness, accuracy, etc.) should be examined item by item to determine any difference between the proposed and ideal solution. Depending on the nature, extent and complexity of the information need, a specific solution may be recommended at this point or a mix of solutions to be explored more fully in a feasibility study. It should be anticipated that these solutions could include data obtained through non-remote sensing methods; existing imagery obtained through remote sensing; or the acquisition of new imagery. Refer to Appendix B for the major sources of existing aerial and satellite data. Table I-4, which lists the categories of remote sensing systems and services which are commonly used in applications of interest to local governments, can be used as a guide in formulating alternative solutions.

It is not necessary at this point to make a detailed evaluation of the potential solutions. Examine the information needs described in Steps 1 and 3 and then make a preliminary judgment regarding appropriate remote sensing approaches. A matrix approach such as the one illustrated in Table I-5 may be helpful for organizing these preliminary assessments.

Step 5 -- Estimate Costs and Benefits

The costs and benefits associated with acquiring the desired product or services should also be described. Procurement, acquisition, installation, training, operating, maintenance, and disposal requirements should be considered as costs. Increases in quality, quantity, scope, extent, efficiency and effectiveness should be considered as benefits. Benefit estimates can be based on existing

TABLE I-4 -- COMMON REMOTE SENSING SYSTEMS

	AIRCRAFT	SATELLITE
PHOTOGRAPHIC	o low, medium, and high altitude o panchromatic, color infrared, color infrared, and multi-spectral o monoscopic and stereoscopic o vertical and oblique	o Mercury o Gemini o Apollo o Skylab S-190A, S-190B
ELECTRO-OPTICAL	o analog and digital Multispectral Scanners	o Landsat Multispectral Scanner (MSS) o Landsat Return Beam Vidicon (RBV)

TABLE I-5 -- PRELIMINARY ASSESSMENT OF REMOTE SENSING APPROACHES

	Low-Altitude Photography		High Altitude Photography		Earth Satellite Imagery
	Black-and-White	Other	Black-and-White	Other	
Natural Features					
Rock outcrops	X				
Stream pattern			X		
River delta					X
Crop lands, etc.				X(infrared)	
Cultural Features					
Urban area		X(color)			X
Historical site	X				
Building, construction, etc.	X				

SOURCE: Department of the Army Office, Chief of Engineers. Remote Sensing Applications Guide, Washington, D.C., 1979.

knowledge of the need and the proposed solution, plus knowledge gained from discussions with practitioners in other agencies and jurisdictions and remote sensing experts. Each cost and benefit should then be plotted over time and, if possible, expressed in dollars.

Costs associated with some of the more advanced remote sensing systems may be difficult to estimate. Further, costs may vary widely depending on the information requirements of the user. Generally, the most significant parameters which affect the cost of acquiring aerial imagery are -- area size, type of terrain, type of sensor, size overlap of frames, type of film and film processing. Contained in Table I-6 are some cost estimates for acquiring aerial and satellite imagery. These are intended as general guidelines only and should be supplemented with additional research.

Step 6 -- Prepare A Work Plan

In addition to the net benefits of a remote sensing product or service, decision-makers will need to know the manpower and resource requirements involved in the procurement before they can determine whether the jurisdiction can, or should, acquire the remote sensing product or service. This information is best provided by a work plan describing the precise scope and estimated cost of the procurement effort.

Accurate time and resource estimates are based on a thorough understanding of the steps involved in procuring a remote sensing product or service, and the Table of Contents to this Technical Guide

TABLE I-6 -- COST ESTIMATES FOR ACQUIRING AERIAL REMOTE SENSING DATA AND COMMERCIAL LANDSAT IMAGERY PRODUCTS

	Low Altitude 1:15,000-1:30,000	High Altitude 1:70,000-1:130,000
CONVENTIONAL PHOTOGRAPHY (data acquisition)		
Panchromatic	$1.50-2.50/km^2	$1.50-2.00/km^2
Color	$2.50-5.00/km^2	$1.50-2.00/km^2
Color infrared	$3.00-5.50/km^2	$1.50-2.00/km^2
THERMAL INFRARED SCANNER (costs include data acquisition plus image products)	500m: $3.00-100.00/km^2	1,500m: $ .50-14.00/km^2
RADAR (costs include data acquisition plus image products)	Variable Altitudes: $10,000-50,000 depending upon project requirements	

SATELLITE (LANDSAT) IMAGE PRODUCTS

Application Area	Typical Product(s)	Processing Cost
Natural resources Geology Mineralization Petroleum indications	False-color/computer-enhanced Landsat images	$900 - $2,500
Ground cover Agriculture Forestry Range management	Classification maps (tabulations optional) (classifitapes are available by product)	$3,300 to $4,500
Land use maps Urban Suburb Rural	Classification maps (tabulations are optional and usually needed)	$3,300 to $10,000
Water resources and quality	Enhanced images	$900 to $4,500
	Classification maps (tabulations optional and usually needed)	$3,300 to $10,000

Note: Processing costs vary depending upon size of the image area processed, degree of enhancement, and sophistication of output products.

SOURCE: Department of Army Office, Chief of Engineers. Remote Sensing Applications Guide, Washington, D.C., 1979.

is a good place to begin. However, to obtain a thorough understanding of what is involved with each step, the entire Guide should be skimmed. A budget and a task schedule should then be prepared. Both should be based on the scope of each step and the number and expertise of persons expected to work on each step.

An estimate of the time and resources required to complete a feasibility study will depend upon the complexity of the proposed remote sensing product or service and the extent to which alternative procurements will be considered. Procurement officers can provide assistance in estimating the time required to develop contract specificiations, prepare Requests for Proposals (RFP) or Requests for Bids (RFB), and allow for responses, evaluation and negotiation. Finally, other jurisdictions with similar procurement experience may be able to assist in estimating time and resource requirements for the Work plan. A final consideration in preparing a Work plan is the budget cycle and its effect on the procurement process.

Step 7 -- Report the Results

The Needs Statement should be in the form of a written document and not a verbal report. Choose your vocabulary carefully before you begin to write. The Needs Statement should be written with the audience -- primarily top management and department administrators -- clearly in mind. It should be kept simple and brief. If you can:

- o Be precise. Avoid vague and inexact usage. Avoid idle words.

- o Spell things out. Avoid acronyms and peculiar abbreviations.
- o Be clear. Consider the efficiency of the simple declarative sentence.

A suggested outline for a Needs Statement is presented in Table I-7. Remember as the Needs Statement is prepared, keep copious notes concerning sources of information and contacts. These will undoubtedly be useful as the procurement process progresses.

MANAGEMENT APPROVAL POINT #1

At this point, top management should make two decisions. The first decision is whether the problem and need are so compelling that the government should commit the manpower, time, and money needed to conduct a feasibility study. If management approves the recommendation to conduct a feasibility study the next decision is whom to select to manage the effort. Guidelines for this decision are contained in the next Task.

TABLE I-7 -- OUTLINE FOR A NEEDS STATEMENT

I. AN ABSTRACT

- A. What is this document?
- B. Why was it written?
- C. For whom was it written?
- D. What does it contain?

II. SUMMARY DESCRIPTIONS OF INFORMATION NEEDS

- A. What type of information is needed?
- B. How will the information be used?
- C. What are the characteristics of the needed information?
- D. What is the importance of filling the information need?

III. DESCRPTION OF THE PROPOSED SOLUTION

- A. What capabilities or characteristics are required to fill the information need?
- B. What potential solutions are available?
  - o non-remote sensing sources
  - o remote sensing sources
    - oo existing imagery
    - oo imagery to be acquired

IV. RELATED PRACTICAL EXPERIENCE

- A. What is the extent of user experience with the requested product or service?
- B. How effective has the product or service been in the past?
- C. What have leading-edge and other jurisdictions done under similar circumstances?
- D. How successful were they?

V. COSTS AND BENEFITS

- A. What results can be expected should the solution be implemented?
- B. What costs and benefits are associated with the product or service?
- C. How were these costs and benefits estimated?
- D. How will these techniques yield new understandings or more useful evaluations?

Table I-7 (continued)

VI. WORK PLAN

A. How long will a feasibility study take and what resources are required to perform one?

B. Assuming that the proposed solution proves to be feasible, how long will the rest of the procurement effort take and what resources are required to complete the procurement?

C. Attach a task schedule and preliminary budget.

TASK 2: ORGANIZE A PROCUREMENT TEAM

Nonstandard products and services are generally too important or too complex to be handled by one individual. Therefore, it is necessary to form a temporary procurement team with individuals who offer the necessary range of knowledge, experience, and skills. The procurement team can be formed in four steps:

1. Choose a procurement manager.
2. Identify the required skills.
3. Obtain the appropriate personnel.
4. Brief the procurement team.

Step 1: Choose a Procurement Manager

The person selected to manage the feasibility study should be selected by top management. This person should be expected to have a broad, top management perspective and possess an objective, analytical mind, good communication skills, and project management experience. The procurement manager should also understand the nature of the underlying problem, as well as any existing financial or organizational constraints, and be capable of understanding the major technical aspects of the procurement.

Where these qualifications can be found in someone from the purchasing agency, this individual should be selected as the procurement manager. The only alternative is to name someone from the chief executive's office. This choice should be made only if the chief executive lacks confidence in the purchasing agency's ability to represent top management's overall perspective.

Step 2: Identify the Required Skills

The procurement manager will want expertise from a requirements specialist, a procurement specialist and one or more technical support specialists. All members should have good communication skills and team-oriented or task force work experience.

A requirements specialist can be anyone with a thorough understanding of the problem and its solution requirements. This person is the user representative on the Feasibility/procurement team. The responsibility of the requirements specialist is to help study the feasibility of the various solution alternatives. Later, this person will help transform the often vague conceptions of the problem and the remote sensing need into concise technical requirements, help evaluate the technical aspects of bids or proposals offered by contractors at various stages of the procurement process, and monitor the performance of the contract.

A procurement specialist is a professional purchasing agent or some other official whose procurement responsibilities have resulted in a sound knowledge of accepted procurement practices and the jurisdiction's procurement codes. This person is the representative of the purchasing department. In this role, he or she will first be responsible for helping the team study the feasibility of various solution alternatives. Eventually, the procurement specialist will help define requirements, and evaluate bids or proposals by providing information on new products and services. He or she will develop specifications and statements for work required by other departments or jurisdictions,

examine the interests, capabilities and records of performance of potential contractors and examine historical cost and price factors. In general, the procurement specialist will be the buyer for the team and handle all pre-awarded interactions between the government and potential contractors.

Technical support specialists can include lawyers, negotiators, photogrammetrists, cartographers, image processing equipment operators, data processing specialists, information specialists, or other persons whose technical skills might be needed to support the procurement manager, requirements specialists, and procurement specialist. In selecting the technical support specialists, the procurement manager must avoid predetermining the solution or inadvertently narrowing the range of options by the selection of people with specific technical biases.

Step 3: Obtain Appropriate Personnel

The procurement manager should approach top management for the authority to make personnel assignments as soon as he has identified the skills and perspectives needed on the procurement team. In seeking this authority, it is extremely helpful to provide top management with procurement-related workload and work schedule of each prospective team member. Once the authority is received, the procurement manager should negotiate actual personnel assignments and commitments with the appropriate department heads.

Sometimes, the appropriate personnel are unavailable in-house. In these instances, the procurement manager must seek permission to approach other agencies, local governments, nearby academic or research

institutions, or local businesses having relevant experience and skills for assistance in the procurement effort. Consultants also can be hired to meet specific needs.

Step 4: Brief the Procurement Team

The procurement manager should now brief the procurement team members on what to expect during the feasibility and procurement effort. This briefing should cover:

- The written Needs Statement prepared in Task 1;
- The objectives and methodology of the ensuing feasibility study;
- The procurement process, including the roles and responsibilities of each team member; and
- A preliminary work plan.

The team manager should then assure the team that every effort will be made to resolve conflicts with their regular workloads, and ask for suggestions or improvements in the work plan.

TASK 3: CONDUCT A FEASIBILITY STUDY

Once the need for a remote sensing product or service has been determined a feasibility analysis should be conducted to:

- Further define the information requirements;
- Examine alternative solutions; and
- Select the most feasible alternative based upon the technical, practical, and economic feasibility of each alternative.

The scope of the feasibility study should be defined by the procurement manager based on the Needs Statement, the cost and commitment of resources anticipated, the importance of the results and the uniqueness of the requirements. The product of this study will be a feasibility analysis report which documents the data collection problems, recommends a remote sensing solution, and details an implementation plan and schedule for the procurement.

The feasibility analysis should be conducted in eleven steps:

1. Refine and prioritize the information requirements.
2. Screen the non-remote sensing alternatives and requirements.
3. List the characteristics of the remotely observable features.
4. Screen the remote sensing alternatives.
5. Determine the resource requirements.
6. Estimate costs.
7. Determine the practical feasibility.
8. Conduct a demonstration test project (optional).
9. Determine the best alternative(s).
10. Report the results.
11. Obtain management approval.

Step 1: Refine and Prioritize the Information Requirements

The first step in the feasibility analysis is to uniformly describe the information requirements for all of the users and uses which were surveyed during the compilation of the Needs Statement. If not already completed, the list of information needs which have been described according to the characteristics presented in Step 1 (Table 1-2) of the Needs Statement should be synthesized and organized in a manner which reveals the commonalities in the information problems. Next, common or shared information needs should be ranked according to a set of priorities. Priorities may be developed according to a number of criteria including number of users, user preferences, and the significance of the information need to program goals and objectives.

Step 2: Screen Non-Remote Sensing Alternatives

Limited resources clearly constrain the procurement team's ability to conduct feasibility studies. Yet, while some alternatives must be eliminated from detailed consideration, the screening must be accomplished in a manner that minimizes the possibility of premature dismissal or careless omission of viable alternatives. Each alternative must also be described in a uniform manner to ensure equal consideration. Steps 2 through 4 are designed to guide the procurement team through a preliminary screening of both remote sensing and non-remote sensing alternatives.

During Step 2, the procurement team should describe and evaluate all non-remote sensing information sources which could be used to

solve the information problem. Non-remote sensing methods for gathering new information could include field enumerations, field surveys, windshield surveys, administrative records, surrogate information or indicators, estimates and predictions. All of these methods have advantages as well as disadvantages which depend upon how the data gathering effort is conducted as well as the anticipated uses of the information end product. For example, field enumerations may require extensive resources in personnel, finances, and time. The accuracy of field enumerations may be negatively affected by inconsistency or bias in the observers. Surveys are subject to errors from improper sample design as well as surveyor bias. In addition, the existing format of administrative records is not always adaptable to new uses. Finally, data available in administrative records are often subject to problems with their validity and reliability when applied to new uses.

Consequently, many of these factors must be taken into account when describing each non-remote sensing method for gathering new data. Each method should be matched to the information need on a requirement by requirement basis. The procurement team should use the list of information requirements in Table 1-1 as a guide in making this evaluation. The procurement team must judge whether the non-remote sensing data collection adequately meets the information requirements. For instance, would a field survey yield data of sufficient accuracy and detail to meet the information need? Would such a survey meet requirements

for timeliness in the availability of the data and would it allow for sufficient frequency in updating theinformation? Keep in mind that at this stage only the technical capabilities of these methods are to be evaluated. However, cost and other resource constraints are also crucial to the feasibility of a given alternative. These will be addressed in Steps 5, 6, and 7 of this Task.

At the conclusion of Step 2, all alternative non-remote sensing information sources or data gathering methods should be uniformly described in terms of their ability to satisfy or meet the information requirements defined in the Needs Statement. Alternatives which do not meet any requirements can be eliminated. The remaining alternatives can then be ranked according to the following combination of factors:

- The number of information requirements adequately met.
- The priority of the information requirements.
- The number of different uses or users which can be satisfied by each alternative.

Step 3: List the Information Requirements in Terms of Their Remotely Observable Features

Prior to this step, the information needs have been described and characterized according to a list of information characteristics. Many times, however, information which is required may not be directly observable or may not be visible. Therefore, it is important to begin thinking in terms of what a remote sensor will see.

The list of information needs should be examined in order to determine what remotely observable features can be used to meet the information need. For example, a Housing and Community Development Agency may want information on neighborhood quality. This type of information may be obtained by using surrogate measures such as house sizes, lot size, presence of debris, condition and presence of paved streets, sidewalks, curbs and gutters, as well as any other appropriate visible indicators of neighborhood quality. Further, information on vegetation stress caused by moisture stress, pollution damage, or disease infestations which is often invisible to the eye can be detected with near-infrared imagery due to changes in reflectance. Thus, in this case, the variation in near-infrared reflectance would serve as the basis for information on vegetation stress. Finally, an energy conservation program may require information on building heat loss. While this information is not directly observable, thermal infrared sensors can detect thermal radiation which can be closely correlated with relative heat loss.

At this point, it is important for the procurement team to adjust the information requirement list to reflect the remotely observable features which will be the object of the data acquisition mission. Thus, a need for urban land use information should be carefully described in terms of the specific categories of visible land cover information which is required. For example, the final product may require discrimination between residential, commercial, industrial, open and other land as well as transitional areas. Also, the identification and inventory of lakes, reservoirs, roadways, power

line right-of-ways, the changing geometry of rivers, shorelines, and off-shore islands to name a few -- could be useful results to anticipate. The list of information needs must be converted into a list of observable features because it is the observable features which are actually recorded by a remote sensor. These observable features in turn form the basis of the image or data interpretation process. The interpretation process is based upon a convergence of evidence whereby several factors are evaluated in the process of identifying the objects in a scene. Several of these factors are listed and described in Table 1-8. The ability of a given remote sensing system to deal with these key factors determines the amount and quality of information which can be obtained from a remote sensing system.

Step 4: Screen Remote Sensing Alternatives

In this step, the team should match the various information requirements with the remote sensing alternatives. Keep in mind that the information requirements have now been defined and characterized in terms of their remotely observable features.

To successfully complete this step, the procurement team must accomplish the following sub-steps:

1. Formulate an array of remote sensing system alternatives.
2. Describe each potential remote sensor system in terms of its technical capabilities.
3. Match the technical capabilities of a particular remote sensor system or combination of remote sensor techniques to the information requirements.
4. Eliminate alternatives which do not meet requirements and evaluate the relative technical capabilities of those which do meet the information requirements.

At the conclusion of sub-step 4, the procurement team will have determined the technical feasibility of each remote sensing

TABLE I-8 -- KEY FACTORS IN IMAGE INTERPRETATION

Shape. The shape or form of some objects is so distinctive that their image may be identified solely from this criterion. Marinas, reservoirs, and agricultural fields are examples.

Size. In many cases, length, width, height, area, and volume of are essential to accurate and complete interpretation.

Tone. Different objects reflect and emit different amounts and wave lengths of energy. These differences are recorded as tonal, color, or density variations.

Shadow. Shadows can help or hinder the interpreter since they reveal or hide some details.

Pattern. Pattern, or repetition, is characteristic of many man-made objects and of some natural features.

Texture. The visual impressions of roughness or smoothness created by some images are often valuable clues in interpretation.

Site. The location of objects with respect to terrain features or other objects is often helpful.

Association. Some objects are commonly associated with other objects that tend to indicate or confirm the other.

Resolution. Resolution always places a practical limit on interpretation. Some objects are too small, or otherwise lacking, to form a distinct image.

SOURCE: G. E. Space Division, Application of Earth Resources Technology Satellite Data to Urban Development and Regional Planning, NASA-Goddard Space Flight Center, Greenbelt, Maryland, 1974 (Document No. 74505265).

alternative under study. Practical and economic feasibility will be examined in later steps. It is important that the procurement team refer to Step 4 of Task 1 and the Appendix for a list of resources to consult for assistance in defining the technical capabilities of various remote sensing alternatives.

Sub-Step 1: Formulate Remote Sensing Alternatives

Remote sensing involves a wide variety of proven and experimental technologies that can be used for obtaining information about objects or phenomena without actual contact with the object or area being studied. Thus, remote sensing includes techniques for locating objects with a metal detector, monitoring smoke stack emissions with an infrared radiometer, measuring distances with a laser, detecting building heat loss from aerial surveys, and obtaining terrain imagery or terrestrial reflectivity from aerial or satellite systems to name but a few applications.

The most commonly used systems employ airplanes and earth-orbiting satellites in combination with passive photographic and/or electro-optical sensors for detecting visible and near reflected infrared energy, multi-spectral scanners for detecting visble and thermal infrared energy and radar for detecting the active microwave region of the electromagnetic spectrum.

While there are many ways to categorize the various remote sensing systems, each must possess a combination of sensor, platform and a record of the data which has been sensed. Table 1- 9 is

TABLE I-9 -- COMMON REMOTE SENSORS, SYSTEM COMPONENTS, AND PRODUCTS

1. SENSORS

Reflected Energy

	Wave Length
Cameras (Photographic)	0.4 um - 7.5 um
Multispectral Scanners	0.3 um - 14.0 um
Radar (microwave scanner)	1 cm - 3 m

Radiated Energy

Thermal Scanners	1.1 um - 14.0 um
Microwave Radiometer	100 um - 3 cm

2. PLATFORM

	Altitude	
Aircraft	15,000 ft.	- low
	15,000-30,000 ft.	- medium
	30,000-40,000 ft.	- high
Satellite	+40,000 ft.	- hyper

3. PRODUCTS

	Primary	Secondary
Image (photographic)	Black & White Color Color Infrared Black & White Infrared	Enhanced & Corrected Imagery Photogrammetric products Interpreted/Thematic Products
Digital (numeric)	Magnetic Tapes	Digitally Enhanced & Corrected Data Digital Data Bases Interpreted & Thematic Products

Table I-9 (continued)

4. ANALYSIS METHODS	
Image	Unaided Optical optical mechanical/electronic
Digital	Computer aided

intended to help acquaint the procurement team with the most widely used remote sensing system components. Be sure to refer to Step 4 in the Needs Identification chapter and the Appendix for sources of technical information on these components.

Sub-Step 2: Describe the Technical Capabilities of Each Alternative

Once the various remote sensing alternatives have been specified, their technical capabilities must be described. Two approaches may be taken to describe the technical capabilities:

- o The level of land use categories which can be identified.
- o The resolution capability of the system.

In fact, combining both approaches is the most effective way of evaluating each alternative. The ability of a remote sensing system to produce useful information is not easily described. The factors affecting a system's ability to resolve objects and produce useful information are complex and highly interrelated. These factors include both the technical capabilities of the system and the environmental complexity of the remotely observed features.

Table 1-10 summarizes the level of land use information which has been obtained from four remote sensing systems. The procurement team may choose to define the technical capabilities of various remote sensing alternatives in terms of the level of land use/land cover classifications which can be identified. The U.S.G.S. has developed a standard land use classification to be used with remote sensor data. As Table 1-11 illustrates, this classification scheme progresses from the general to the more detailed. Typically, Level 1 land use

TABLE I-10 -- URBAN ACTIVITIES INDENTIFIABLE AT FOUR LEVELS OF INTERPRETATION

Landsat Satellite Imagery	High Altitude Photography RB-57, 1:120,000	High Altitude Photography RB-57, 1:60,000	Medium Altitude Photography Black-and-White, 1:15,800
Core Residential/Commercial	Individual Structures Residential Areas Shopping Plaza Commercial Cluster Strip Commercial Administrative Buildings Schools University Complex Cemetery Golf Course Baseball Diamond Drive-In Theater Marinas Heavy Industry Tank Farm Light Industry	Single Family Residential Swimming Pools Apartment Complex Mobile Home Park Mobile Home Sales Parking Lots with Cars Boat Dock and Small Boats Junk Yard Extracting Industry Fabricating Processing Gas Storage	Housing Types High Rise Structures Garden Apartments Pleasure Boats Buildings Under Construction Institutional Buildings Power Boat -- Wake Park Power Plant -- Coal Piles Overhead Crane Water Pipes Open Storage Area
Excavations	Excavating Industry		
Airports	Airport Terminal Buildings Aircraft Hangars		
Highways	Highway Interchanges Divided Highways Bridges Rest Areas		
Railroads	R.R. Switching Yards		R.R. Box Cars
Utilities	Power Line Right of Way Secondary Roads Tertiary Roads Port Facilities -- Ships		

Source: Gary K. Higgs and M. Sullivan, "A Comparative Analysis of Remote Sensing Scale/System Attributes for a Multi-Level Land Use Classification System." Proceedings of the American Society of Photogrammetry Fall Convention, Falls Church, VA, 1973.

TABLE I-11 -- U.S. GEOLOGICAL SURVEY LAND USE AND LAND COVER CLASSIFICATION SYSTEM FOR USE WITH SENSED DATA

LEVEL I		LEVEL II	
1	Urban or Built-up Land	11	Residential.
		12	Commercial and Services.
		13	Industrial.
		14	Transportation, Communications, and Utilities.
		15	Industrial and Commercial Complexes
		16	Mixed Urban or Built-up Land.
		17	Other Urban or Built-up Land.
2	Agricultural Land	21	Cropland and Pasture.
		22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas.
		23	Confined Feeding Operations.
		24	Other Agricultural Land.
3	Rangeland	31	Herbaceous Rangeland.
		32	Shrub and Brush Rangeland.
		33	Mixed Rangeland.
4	Forest Land	41	Deciduous Forest Land.
		42	Evergreen Forest Land.
		43	Mixed Forest Land.
5	Water	51	Streams and Canals.
		52	Lakes.
		53	Reservoirs.
		54	Bays and Estuaries.
6	Wetland	61	Forested Wetland.
		62	Nonforested Wetland.
7	Barren Land	71	Dry Salt Flats.
		72	Beaches.
		73	Sandy Areas other than Beaches
		74	Bare Exposed Rock.
		75	Strip Mines, Quarries, and Gravel Pits.
		76	Transitional Areas.
		77	Mixed Barren Land.

Table I-11 (continued)

8	Tundra	81	Shrub and Brush Tundra.
		82	Herbaceous Tundra.
		83	Bare Ground Tundra.
		84	Wet Tundra.
		85	Mixed Tundra.
9	Perennial Snow or Ice	91	Perennial Snowfields.
		92	Glaciers.

SOURCE: Anderson, J.R., et. al., A Land Use and Land Cover Classification System for Use with Remote Sensor Data, Geological Survey Professional Paper 964, U.S. Government Printing Office, Washington, D.C., 1976.

information can be obtained from Landsat Satellite data; while progressively lower altitudes and large scales are required to detect more detailed levels of land use information. However, these relationships are not absolute. In some cases Level II and even Level III categories have been interpreted from Landsat data.

In addition, the concept of resolution can be used to discriminate between the technical capabilities of various remote sensing systems. In general, there are three levels of image discrimination which require increasing levels of remote sensing resolutions. They are:

- o Simple Detection. Is an object or feature present in the image or not present in the image?
- o Classification. Is there enough information in the image to label the object or feature?
- o Analysis. Is there enough information in the image to discuss the feature or object?

There is a scale of the image data which is appropriate for each of the three levels of discrimination. However, the ultimate user of the information must determine the level of image discrimination which is required. Finally, the degree of image discrimination and accuracy in both identification and measurement is dependent upon the spatial, spectral, radiometric, and temporal resolution values which can be achieved from a given remote sensing system.

Following is a brief discussion of spatial, spectral, radiometric, and temporal resoultion and the interrlationship between resolution and accuracy in image interpretation and measurement. The procurement team need not immerse themselves in technical details, but should seek to gain a general understanding of these

concepts. The Remote Sensing Applications Guide produced by the Army Corp of Engineers (see Table 1-3 for full citation) is a particularly helpful reference for a more detailed explanation of these concepts as well as an excellent over-all source of information on remote sensing systems.

Spatial resolution is the minimum size of two objects or features that a sensor can record as two distinct entities. For camera systems, spatial resolution is usually expressed as ground resolvable distance (GRD). In multispectral scanning systems, spatial resolution is defined as the instantaneous field of view (IFOV). Further, spatial resolution and scale are often related and can be determined by the altitude of the sensor platform, along with sensor parameters such as focal length. Altitude and platform type tend to define remote sensing scales as follows:

- Conventional aerial photography taken at an altitude of 1,000 to 15,000 feet produces a scale range between 1:2000 and 1:30,000.
- Intermediate altitude imagery, typically flown at an altitude between 15,000 and 30,000 feet, produces a scale range between 1:30,000 to 1:60,000 and smaller.
- High-altitude aerial imagery flown above 30,000 feet produces a scale range between 1:60,000 to 1:400,000 and smaller.
- Orbiting satellite imagery produces a scale range between 1:250,000 and 1:3,000,000. Further, even though the GRD or spatial resolution of objects or phenomena is based on many factors, given a scale, certain spatial resolution can be expected:

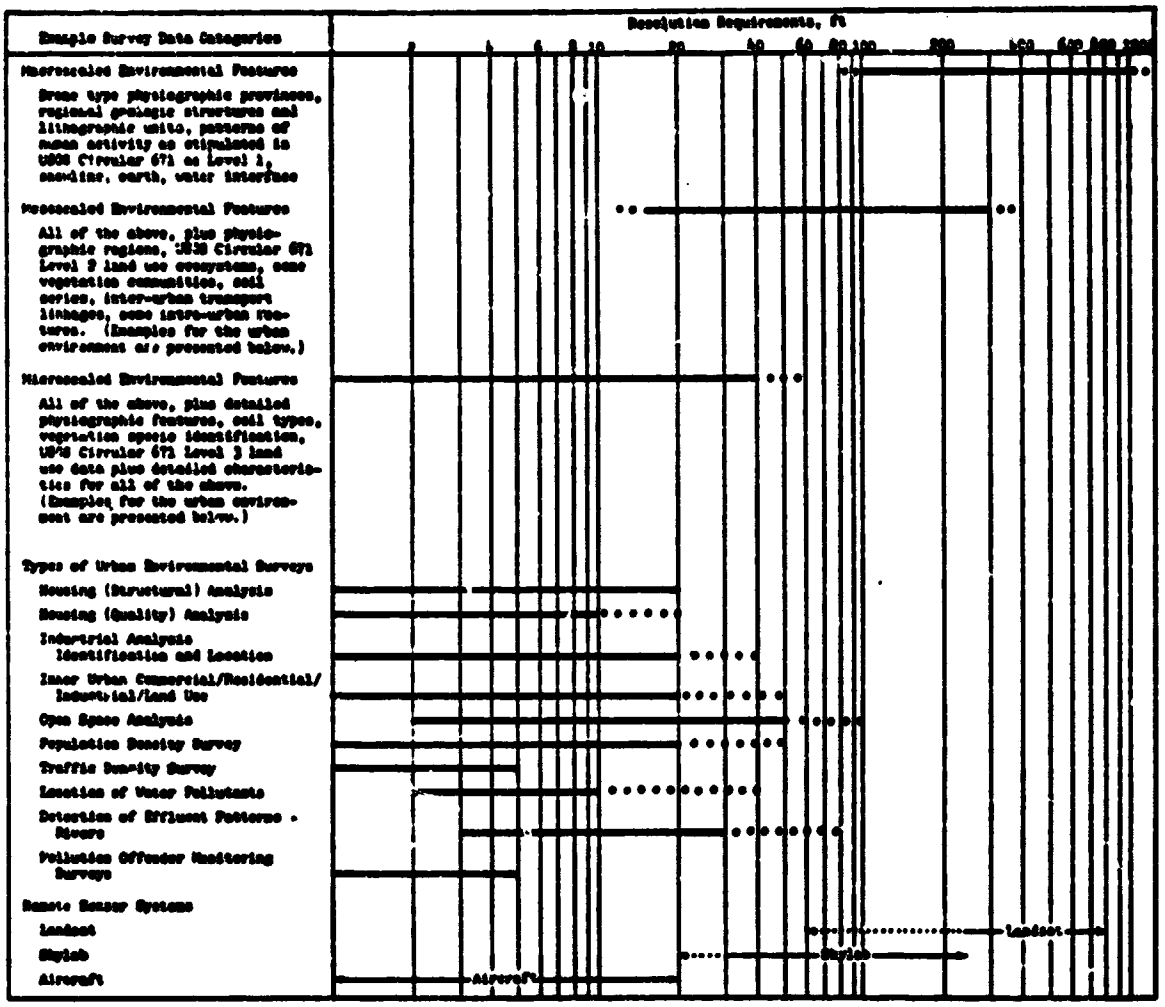
Scale	Ground Resolvable Distance (GRD)
1:3,000,000	80 m
1:1,000,000	50 m
1:250,000	30 m
1:100,000	20 m
1:50,000	10 m

Table 1-12 illustrates some of the spatial resolution requirements for environmental planning surveys and indicates the remote sensing systems which provide suitable spatial resolution.

Spectral resolution refers to the portion and width of the electromagnetic spectrum sensed, and the number of channels or bands used. It is a function of an instrument's film, filters, or scanner construction. Some spectral regions are more useful for certain applications than others. For instance, the red/near infrared spectral region (Landsat band 6) can image certain tonal contrasts that can be used to identify land use practices such as gross levels of urbanization, and rangeland, and forest vigor. Also, the near infrared region (Landsat band 7) can be used for the discrimination of land/water boundaries. Table 1-13 summarizes the appropriate wave lengths or spectral regions recorded by various remote sensing systems.

Radiometric resolution refers to the sensitivity of a sensor to the spectral band that it is recording or imaging. In both photographic and multispectral scanner systems radiometric resolution can be discerned as gray levels which range from black to white. The signals may represent either reflected light in the visible or near infrared portion of the spectrum or emitted energy in the thermal infrared and passive microwave part of the spectrum. Therefore, the more gray levels represented, the higher the resolution. For example, some systems have spectral bands 20 nanometers wide divided into 256

TABLE I-12-- OPTIMUM RESOLUTION REQUIREMENT FOR ENVIRONMENTAL PLANNING SURVEYS



SOURCE: Lintz, J., and Simonett, D., Remote Sensing of the Environment, Addison Wesley, Reading, Mass.

TABLE I-13 -- GENERAL CHARACTERISTICS OF REMOTE SENSING SYSTEMS[a]

Spectral Region and Sensor Systems	Approximate Wavelength interval (micrometers)	Atmospheric Penetration Capability[b]	Day-Night Capability	Real-Time Capability[c]	Geometric Rectification[d]
Ultraviolet (Optical-mechanical scanners, and cameras with infrared film)	0.01-0.4		Day only	Yes	Good
Visible (Optical-mechanical scanners, conventional camers with film, and vidicons)	0.7-3.5	H	Day only[e]	Generally No[f]	Potential metric quality
Reflectance Infrared (Conventional cameras with infrared sensitive film, solid-state detectors in scanners and radiometers)	0.7-3.5	H. Sg	Day only	Generally no[f]	Potential metric quality
Thermal Infrared (Solid-state detectors in scanners and radiometers, quantum detectors)	$3.5-10^3$	H. S	Day or Night	Yes	Good
Microwave (Scanners, radar and radiometers, antennas and circuits)	10^3-10^4	H.S.F.	Day or Night	Yes	Poor/ Fair[g]

Table I-13 (continued)

Notes: a. Systems characteristics enclosed by the solid lines are those most commonly employed in planning applications today.

b. Denotes the atmospheric conditions which can be penetrated by energy in this portion of the electromagnetic spectrum where:

H = haze. S = smoke. Sg = smog or clouds. R = rain.

c. This refers to the ability to evaluate a sensor system's output as the original information is acquired.

d. Denotes the potential for planimetric mapping.

e. Discounting the use of active optical systems such as the Edgerton flash units, laser line tracers, or light amplification systems.

f. The potential for real-time viewing exists in scanner systems, and panchromatic film could be viewed in near-real-time by using a Bimat type of process.

g. Can potentially be metric in synthetic aperture systems.

SOURCE: Estes, John E., "Remote Sensors: What They See and How It is Recorded," in Remote Sensing for Planners, edited by Kristina Ford, Center for Urban Policy Research, Rugters, New Jersey, 1979.

equal gray scale steps. Obviously, the former has greater radiometric resolution. In general, then, the greater the radiometric resolution, the greater the opportunity to discriminate between objects or features (holding spatial resolution constant).

Temporal resolution deals with the time (of day or year) that an object or feature must be observed in order to record the needed data. This optimum viewing time is a function of the temporally changing conditions of the object or feature. For instance, the spatial, spectral or radiometric resolution afforded by multispectral scanners, may make them good choices for crop identification. However, certain crops such as corn and soybeans are too similar spectrally to be differentiated during certain stages of the growing season. Thus, the usefulness of the data obtained in such a remote sensing operation could be crucially affected by the timing of the mission. In addition, information requirements which are temporally linked, such as monitoring changes over time, may necessitate a stayed or repeated remote sensing mission.

Regarding the overall accuracy of the data required, it should be decided whether the remote sensing data to be gathered are to be directly comparable with the information that is currently being gathered and therefore of similar accuracy. On the other hand, for data not presently compiled, the Requirements Specialist will have to decide on the accuracy needed.

Finally, what will actually be possible in extent and accuracy of information will be dependent upon the available sensor/data. As

a simplified example, consider the following -- if an area containing square fields were photographed and the sides of the fields were sharply defined, the measurable accuracy of a side of any one of the fields would be $X \pm R/5$, where X is the true length of the side (in feet) and R is resolution in feet. If the measurement were repeated a large number of times, about two-thirds of the measurements would lie within the limits described above. If, as is typical, that errors of measuring length or width have a high positive correlation, the range of error for measured area is approximately:

$$(X + R/5)^2 - (X - R/5)^2,$$

which reduces to

$$4/5RX.$$

If we assume normality of the measure of the area and assume that 4/5RX covers tne middle two-thirds of the distributions, then the stnadard error is

$$2/5RX$$

and the coefficient of variation is

$$\frac{2/5RX}{X^2} \text{ or } (2/5)\ (R/X)$$

Therefore, if we were measuring a 40 acre square field with an instrument that gave 100 feet ( ) resolution, then the coefficient of variation would be

$$(2/5)\ (100/1320) = 3\%$$

The point of this is tha: as smaller and smaller fields are measured with the same resolution, the error increases. Also, note that for a given size field, the coefficient of variation is proportional to resolution. This means that as resolution increases (i.e.,

goes from 100 feet to 10 feet) statistical accuracy is improved. However, as resolution increases, the quantity of data to be analyzed increases. Thus, for a given task there is a balance between the benefits of accuracy and the costs of equipment and/or data processing that must be considered.

Multiple Strategies

Frequently it is necessary or desirable to apply multiple strategies to obtain the most useful information from remote sensing. Already discussed earlier in the Guide was the concept of multiple users for the data generated from a remote sensing project. Such multiple users improve the cost effectiveness of a remote sensing technique. Other approaches which incorporate a multiple set of strategies or techniques are:*

- o Multispectral discrimination
- o Multidate discrmination
- o Multisensor combination
- o Multistage approaches

The procurement team should determine if the use of one or more of these multiple strategies will significantly enhance the technical feasibility of the individual alternatives. If so, the multiple strategy concept should be developed as an alternative and evaluated according to the same methods used to evaluate the other alternatives under consideration.

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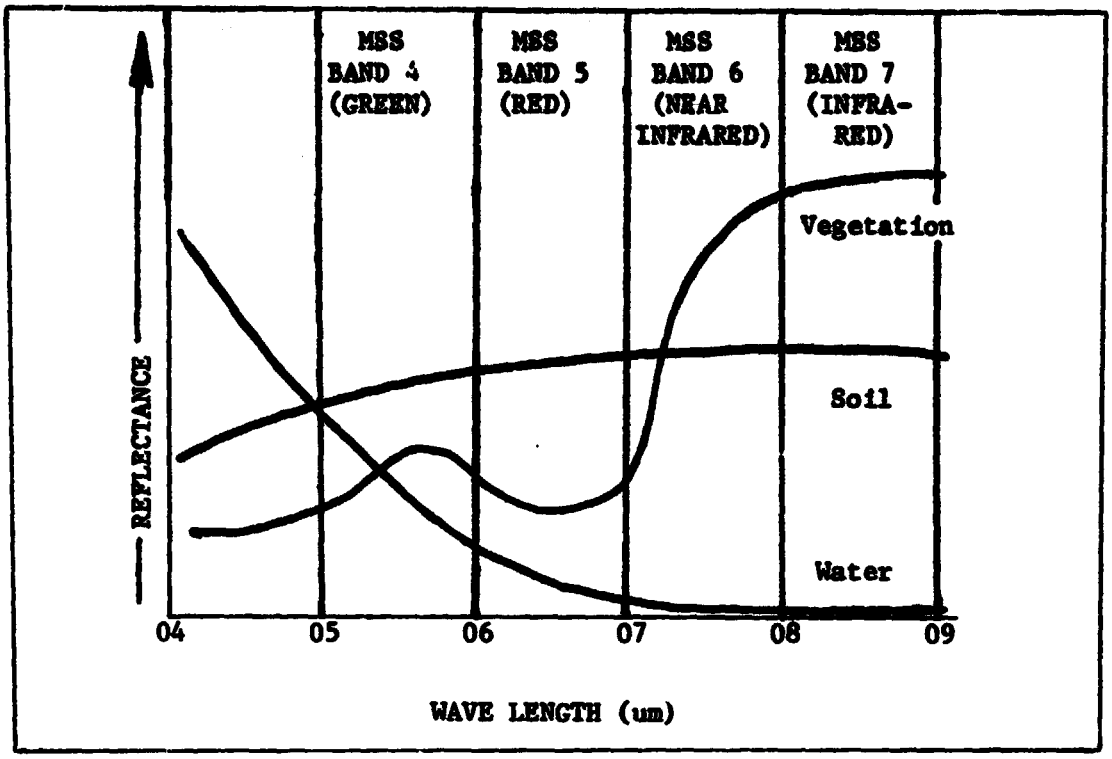
*Joseph R. Lintz, Jr., David S. Simonet. Remote Sensing of the Environment (Reading, Massachusetts: Addison Wesley Publishing Company, 1976. pp 111-116)

Following is a discussion of four multiple strategies to provide background for the procurement team unfamiliar with these concepts.

Multispectral discrimination relies on the use of several spectral bands to resolve individual objects or features of interest. Because gross physical objects or phenomena can have unique spectral characteristics, sensor systems employing more than one spectral band often allow several gross features to be identified according to general spectral reflectance values. Figure 1-1 displays several such reflectance curves or spectral signatures.

Further, with various types of equipment, the bands may be added, subtracted , or ratioed; and a specific combination of reflectance values can be related to particular features. Also, statistical and pattern routines can be performed, as well as filtering out unwanted reflectance values, smoothing of the data, and feature edge enhancement. Last, since a multispectral sensor system records an object's spectral reflectance in several bands simultaneously, the combination of the different reflectance values of each band can often produce a spectral signature which can be used as a basis for identifying objects of phenomena.

A multidate or multitemporal strategy utilizes the time varying properties of a scene to aid in discrmination. For example, a spectral signature can change in response to changing environmental factors such as sun angle, leaf cover, atmospheric conditions and changes in the feature of interest itself. Thus, careful selection of the optimal time for a remote sensing mission will ensure the greatest probability of obtaining the desired information. In



SOURCE: Eliason, Eric M., et. al., "Simulating True Color Images of Earth from ERTS Data," Proceedings of the American Society of Photogrammetry 41st Annual Meeting, 1975.

FIGURE I-1 -- SIGNATURES OR GENERALIZED SPECTRAL REFLECTANCE CURVES (MULTIBAND PHOTOGRAPHS)

addition, repeated data collection provides information on how spectral signatures of given features change. This accumulation of data aids in object identification and makes it possible to detect and monitor changes in land use resulting from man's activities as well as natural changes. Landsat, because of its routine 18 day repeat cycle, lends itself to multidate data collection.

Multisensor combinations obtain a wide range of data simultaneously. Data from non-imaging sensors, imagery from the visible portion of the spectrum, and information from beyond the visible portion of the spectrum can be gathered simultaneously and compared.

The multistage approach can involve either multistage surveys or multistage samples. Multistage surveys involve multiple image acquisition missions using different platforms at different altitudes, producing various scales and levels of detail. Using this approach, the first survey is usually accomplished at high altitudes providing small scale imagery useful for synoptic views of large areas. From this data, specific areas can then be pinpointed for more detailed observation at larger scales. The more expensive large scale image acquisition is thus used to obtain detailed information only where conditions or information requirements warrant it.

In addition, once a small area or unit has been examined and identified with large scale imagery its characteristics can be applied throughout the study area. Thus, interpreters are often able to extrapolate from a "defined" landscape unit to similar units.

Multistage sampling techniques are used to obtain quantified measurable data through the use of remotely sensed data obtained at

various scales and levels of detail. The multistage sampling approach relies on statistical methods and probability theory to produce reliable quantitative estimates of remotely observed features. Thus, multisampling techniques have been used to obtain reliable estimates of the quantity, quality, and distribution of resources of vast areas from relatively small samples.

Sub-step 3: Match the Technical Capabilities of Each Remote Sensing Alternative to the Information Requirements

Next, the procurement team should match the various information requirements identified earlier with the capabilities and characteristics of each alternative remote sensing sytem. Each information requirement should be listed along with the capability of a specific remote sensing alternative and assessed on a requirement by requirement basis. Keep in mind that the information need must be analyzed in terms of the observable features which are to serve as indicators or proxies for the information which is needed. Therefore, the procurement team should compare the resolution (spatial, spectral, temporal, and radiometric) capabilities of each remote sensing system being considered with requirements such as size of the area to be covered, the level of detail to be observed, the frequency of observations, the accuracy of the data collected, when the data must be available, and any other factor, historical or anticipated, that is basic to the collection or definition of the defined information need. At this point, any of the remote sensing systems which do not fulfill critical requirements should be eliminated.

Sub-Step 4: Evaluate the Alternatives

Keep in mind when evaluating the technical capabilities of various remote sensing systems that once image or data acquisition is complete, the data set is fixed and cannot be expanded. However, certain enhancement techniques ranging from simple photo enlargements (which change scale factors proportionately) to sophisticated computer techniques, such as color composting, digital density slicing, contrast stretching, etc., can be used to enhance the image or data interpretation process. Thus, the use of these enhancement techniques expands the amount of information which can be obtained from the original set of data. Consequently, when evaluating the technical capabilities of the alternatives the procurement team should not overlook the various enhancement techniques, which are available to aid in the analysis of the data obtained from remote sensors.

Finally, after the procurement team has eliminated the alternatives which fail to satisfy the information requirements, the remaining alternatives should be ranked according to the following combination of factors:

- The number of information requirements adequately met.
- The priority of the information requirements (for example, some information requirements may be essential, such as area or time frame, while others may be only desirable).
- The number of different uses or users which can be satisfied by each alternative.

Step 5: Determine Resource Requirements

The procurement team needs to understand the resources (time, equipment, personnel and skills) required to acquire and/or utilize

remote sensing imagery in order to estimate costs, determine impact or effectiveness, and assess governments' need to rely upon a contractor to provide the products or service. The preceeding step has produced an assessment of the technical feasibility of each alternative. The objective of this step is to define the resource requirements associated with each alternative in order to estimate costs or economic feasibility as well as practical feasibility.

A given remote sensing project may be very complex. Following is a delineation of the major elements in a remote sensing project. The resources (time, equipment, personnel, and skills) associated with each element should be determined.

- Remote sensing mission planning
- Data acquisition
  primary - (imagery)
  ancillary - (ground truth, sensor calibration)
- Data processing
  reformatting, rectification, editing, scale change, enhancement, integration of collated data
- Data interpretation
  manual approach
  automated or numeric approach
- Data presentation
  output products, formats, processes
- Data management, application, and utilization
- Data updating

This list should include all the resources a contractor would need to develop and implement or deliver the product or service in question, plus all the resources the government would need to solicit and evaluate proposals, conduct negotiations, support the contractor's

efforts, and operate or use the resulting product or service. It should include the various types of labor, material, equipment, facilities, and other resources needed. The procurement team should describe the solution alternative's labor requirements by skill, experience, and capability, and its equipment and facility requirements by type, size, and location. The team should then estimate the quantity and cost of each required resource, adding an allowance for profit.

Finally, when estimating the resource requirements for a given remote sensing technique the procurement team should not overlook ground control data requirements. Ground control data should be acquired from the most economical and readily available sources. U.S.G.S. topographical maps are one of the most widely used sources. When existing sources of data are not adequate field collection will be required. However, this is generally more expensive and time-consuming.

The type of ground control data needed will vary according to the data analysis methods to be used. For example, if spatial characteristics are to be used as the basis for image interpretation, knowledge about the spatial geometry of the features of interest will be needed. Likewise, if automated data analysis of Landsat imagery is to be used, then ground control must consist of knowledge of the spectral reflectance characteristics of the features to be identified. Thus, field measurements with portable radimeter may be required. Another common type of ground control are ground targets which are used to relate positions on the ground to positions in an image. Ground targets located with standard surveying methods are essential when close precision in locating features is desired. Otherwise, cultural or natural features such as road intersections, buildings or stream tributaries should suffice.

Step 6: Estimate Costs

Various methods are available to estimate costs. Estimates of the quantities of each required resource and the associated costs can be obtained by using unadjusted current data, contractor estimates, estimates derived from the experiences of other jurisdictions, engineering studies, statistical estimation, or uniform cost factors. However, each of these tools has limitations. Unadjusted current data should be used only for costs that are not expected to change significantly in the future. Contractor estimates should not be mistaken for commitments. Information obtained from other jurisdictions frequently needs to be adjusted to account for changed circumstances. Engineering estimates -- the use of professional experts to estimate the appropriate quality and cost of each product or service component -- are useful in estimating the costs of new products or services, but require substantial time. Statistical estimation is useful for alternatives with new and perhaps unusual characteristics where statistics or data on past performance exist. Uniform cost factors can be used to calculate certain types of costs that are uniform throughout a government (e.g., fringe benefits and overhead), as long as they are regularly updated.

Regardless of which method is used to estimate costs, the procurement team should keep the following princples, especially the last two, clearly in mind:

- For each alternative, analysis should determine which costs are fixed and which are variable.
- The cost analysis should focus on those cost elements likely to be substantial and that seem likely to vary significantly among the alternatives being considered.

- The marginal, incremental, or additional costs incurred for a specific alternative, not the average costs, are relevant.

- Sunk costs, those costs already incurred, are irrelevant and should not be considered.

- Costs should be considered regardless of where they are carried on the accounting books, what organizational unit they are connected with, or where the money comes from, since costs are frequently borne by more than one department, funding source, or account.

- The future cost implications of each alternative should be considered.

- Some alternatives will generate revenues, other will be associated with Federal Government grants. These revenues, when believed to be substantial, should be estimated and considered either as an offset to total costs or as a side benefit.

- Some alternatives may affect the costs of other programs. These can be important considerations, especially for analyses considering large-scale changes and should be estimated despite the complexity and difficulty of the task.

- If resources are put into one alternative, opportunities to use the same resources elsewhere are foregone. The value of foregone opportunities is the opportunity cost of putting resources into the selected alternative. This value is, therefore, relevant to alternative selection.

Step 7: Determine Practical Feasibility

The practical feasibility of remote sensing procurements should also be evaluated. The procurement team should use the

following questions as a guide in assessing the feasibility of each alternative:

- How many agencies, both internal and external to the government must cooperate or participate in order to ensure successful implementation? (The more people and groups required to provide approval or support, the more difficult implementation is likely to be.)

- To what extent does the alternative involve services that are clearly visible to the public? Are there existing client groups whose interest will be affected, particularly by a cutback in existing services? (Alternatives that maintain or increase existing levels of services will present fewer implementation difficulties than those that recede the level of service.)

- To what extent does the alternative threaten important officials by reductions in power, prestige, or privileges? (Such individuals, or course, can be expected to resist implementation.)

- To what extent are special personnel capabilities required? Will additional training be required? Are needed personnel likely to be available and obtainable within the existing civil service system? If not, can special provisions be made for obtaining such personnel?

- To what extent does the alternative require changes in the routines of government employees who may be unable or unwilling to conform to the alternative's routines?

- Are sources of funds and their availability fairly certain? To what extent does the alternative call for added funds in the face of tight revenue constraints?

- Are there complicated legal questions and, if so, are changes such as new legislation required? What is the likelihood that these changes would be made? (At the very least, this factor will probably impose delays.)

- To what extent has public debate galvanized opinions for or against the alternative?

- To what extent does the alternative require space or facilities that may be difficult to obtain?

- To what extent does the alternative involve significant technological uncertainties that could increase costs, reduce effectiveness, and delay or even prevent implementation?

- Has a recent crisis generated support for one of the alternatives? (Implementation problems might be alleviated if the problem is clearly recognized by the community.)
- How sensitive is the alternative to timing? (Frequently, implementation of program alternatives is delayed for weeks, months, or sometimes a year or more.)

Step 8: Conduct a Demonstration Test Project (Optional)

A demonstration test project or trial period may be warranted. The factors to be considered in making this decision are:

- Cost, time, and amount of resources to be committed.
- Importance of the results.
- Visibility of the project.
- Technical risk (uniqueness and use of innovative techniques).
- Technical development.
- Cost estimates.
- Organizational impacts.

If a demonstration project appears warranted, the procurement team should determine what resources are available to assist with the demonstration project. Federal sources such as NASA Regional Application Centers and other grant programs should be considered. If the application has widespread market potential, industry may be willing to share the risks or help apply for the grants.

Generally, however, it is not a good idea to require companies to perform demonstration without payment as a part of the bid requirements. Such a requirement will probably reduce the likelihood of contractors responding and increase costs.

Step 9: Determine the Best Alternative

As noted earlier, the purpose of the feasibility study is to determine which alternative is best able to meet the jurisdiction's needs. To accomplish this, the analysis of the technical, economic, and practical feasibility should be organized so that comparisons may be made among the alternatives studied. The procurement team may well discover that more than one technique or process is needed to adequately meet the technical requirements. It is not necessary to recommend a single technique at this stage. In the next chapter, a set of technical specifications stressing performance will be developed. The most cost-effective procurement will result when all the techniques capable of meeting the specifications are allowed to be bidded or proposed.

Once a conclusion has been reached on which remote sensing techniques or combination of techniques is best able to meet the jurisdiction's information needs, the procurement team should look to see if the government has, or can obtain, the resources required to produce the item or provide the service themselves.

A conclusion should be reached on whether it is better to buy or produce the required remote sensing product or service. This conclusion should be based on the availability of the necessary resources within government, the relative cost of both options, and other quality, capacity, labor scheduling and cost factors listed in the Make or Buy Decision Checklist presented in Table 1-14.

Step 10: Report the Results

The feasibility study, to be effective, must be a written

TABLE I-14 -- "MAKE -OR- BUY" CHECKLIST

PLACE A "✓" ON THE LINE NEXT TO EACH TRUE STATEMENT BELOW

FACTORS FAVORING: "MAKE"	FACTORS FAVORING: " BUY "	
		QUALITY FACTORS
_____		Government is fully capable of controlling quality.
	_____	Government lacks special quality control equipment or know-how.
	_____	An independent, unbiased review or opinion is needed.
_____		Fresh approaches, new departures, and innovative thinking are available from existing government personnel.
	_____	Fresh approaches, new departures, and innovative thinking are needed, but unavailable from existing government personnel.
_____		Private contractors are unlikely to understand the problem or need without a considerable educational effort.
_____		Private contractors do not provide the appropriate quality of work.
		LABOR FACTORS
_____		Technical and design expertise is available to the government.
	_____	The government lacks special expertise or know-how.
_____		Present workloads will allow the work to be performed without increasing the staff size.
_____		Present workloads would necessitate increasing the present staff size to perform the work, but there is a long-term need for additional staff anyway.
	_____	Present workloads would necessitate increasing the present staff size to perform the work, and there is no long-term need for additional staff.
_____		The government wants to develop and maintain the necessary technical knowledge and experience.
_____		Newly gained knowledge, skills, and expertise useful in future work will remain largely with the persons who perform the work.

Table I-15 (continued)

PLACE A "✓" ON THE LINE NEXT TO EACH TRUE STATEMENT BELOW

FACTORS FAVORING:	
"MAKE"	"BUY"
____	
	____
____	
____	
____	
	____
____	
____	
	____

CAPACITY FACTORS

The government can satisfy all equipment, facility (i.e., space) and material needs.

The government lacks special equipment, facility (i.e., space), or materials.

Underutilized, government-owned equipment or facilities can be used.

Other long-term productive uses exist for currently unavailable equipment or facilities.

SCHEDULING FACTORS

All the necessary resources can be brought together at the right times.

The government cannot get all the necessary resources together at the right time.

The government needs full control over the work schedule.

COST FACTORS

The "make" option costs less than the "buy" option.

The "buy" option costs less than the "make" option.

report. This report should include background material on the program, a problem statement, a technical description of the proposed solution, the solution's potential benefits and estimated costs, a feasibility assessment, a description of the alternatives, and an implementation plan. A more detailed outline is suggested in Table 1- 15.

In some cases, top management may also request an oral presentation. This offers the staff an opportunity to emphasize important points, and offers decision-makers an opportunity to ask questions and seek clarification. Oral presentations must be based solely on the written report. More guidance on planning, organizing, developing, and delivering presentations can be found in the following references:

- o Effective Presentations
  By Howard Hodnett
  West Nyack, N.Y.: Parker Publishing Co., 1967.

- o Presenting Technical Ideas: A Guide to Audience Communication
  By W. A. Mambert
  New York: John Wiley and Sons, 1968.

MANAGEMENT APPROVAL POINT #2

With the feasibility study complete, top management is now ready to approve or reject the procurement request. In reaching this decision, top management decision-makers should review the following questions:

- Is the original problem or need still a pressing concern?
- Did the staff recommend the best alternative from a political, managerial, technical, and cost-benefit perspective?
- Do the necessary time, manpower, facility, and financial resources exist to implement the recommendation?
- Who should be responsible for the procurement effort? The current procurement manager?

TABLE I-15 -- SUGGESTED CONTENTS OF A FEASIBILITY STUDY REPORT

BACKGROUND

- Describe the program's goals, objectives, and evaluation criteria
- Describe the purpose, scope, methodology, and participants in the feasibility study.

PROBLEM STATEMENT

- Describe the information problem or need.
- Describe its significance.

RECOMMENDED SOLUTION

- Describe the recommended remote sensing technology or combination of techniques.
- Describe how its performance characteristics match up against the initial information requirements.
- Describe how it is expected to resolve the problem.

POTENTIAL BENEFITS

- Describe the benefits associated with the recommended solution (e.g., improved quality, increased effectiveness, increased efficiency ...).
- Describe the uncertainties associated with these benefits.
- Describe the recipients of these benefits.

ESTIMATED COSTS

- Describe the personnel, time, equipment, facility, and monetary resources required to implement the recommended solution.
- Describe the availability of these resources.
- Describe the organizational, procedural, legal, and other practical considerations that must be addressed before the recommended solution can be implemented.

Table I-15 (continued)

FEASIBILITY ASSESSMENT

- Describe the technical, practical, and economic feasibility of the recommended solution.

ALTERNATIVES

- Describe each alternative that was considered.
- Describe their technical, practical, and economic feasibilities.

IMPLEMENTATION

- Describe what is required to acquire the proposed product or services, including such concerns as finances, time, manpower, policies, procedures, facilities, equipment, and organization.
- Prepare a work plan and schedule (including target dates and personnel requirements) for defining the requirements, soliciting responses, evaluating responses, awarding a contract, and fulfilling the contract.

SECTION II -- PREPARING SPECIFICATIONS AND EVALUATION CRITERIA

Once the information need has been clearly established and the most feasible remote sensing approach for meeting that need is identified, the procurement team can begin to define the appropriate product or service requirements. These requirements include technical and contractual specifications and other evaluation criteria. By developing a firm, unambiguous statement of the requirements suitable for guiding potential contractors or government staff towards resolution of the stated need, the requirements definition phase establishes a framework for everything else that occurs in the procurement process. There are three major tasks to be completed in this phase:

- Define the full scope and nature of the requirements.
- Establish contractual strategy and specifications.
- Develop criteria for objectively evaluating bids or proposals.

Poorly formulated, inadequate, or inaccurate specifications often cause significant negative impacts. If the requirements are not clear and precise, the purchased product or service will not adequately fulfill its intended use. In addition, costs may be higher than necessary or products which are not needed may be purchased. Finally, competition may be reduced or excessive risks may be assigned to the contractor thus raising costs to the purchaser.

TASK 4: DEVELOPING TECHNICAL REQUIREMENTS

Technical requirements are usually formulated as design specifications, performance specifications, or work statements. Design specifications describe precise physical characteristics such as configuration, measurement, tolerance, material, aesthetics, labor, and procedural requirements. Performance specifications describe specific results or capabilities such as function, speed, capacity, maintainability, reliability, safety, productivity, and output requirements. Work statements, or statements of work, describe the tasks that must be performed by the winning contractor.

The procurement team may use any or all of these three forms of technical requirements. However, performance specifications are recommended because they encourage innovation, are less likely to be unduly restrictive, and force the procurement team to be more attentive to the need rather than to the design of the necessary item. Design specifications are useful because they can easily ensure compatibility with existing systems and because performance specifications are often used as an excuse for not stating requirements clearly, accurately, or comprehensively. Work statements are useful in professional service procurements.

Technical specifications should describe essential and nonessential but desirable requirements. The difference between essential and nonessential but desirable requirements is quite important. A proposal that fails to meet even one essential requirement is, by definition, nonresponsive and unacceptable; yet a proposal that fails

to meet several nonessential requirements can still be considered responsive and acceptable it if meets all the essential requirements. However, the overall acceptability of one proposal relative to other proposals is often a function of its responsiveness to the nonessential but desirable requirements.

One of the primary difficulties in developing specifications for remote sensing procurements is that there are very few accepted standards. Also, many applications and techniques are new and still rapidly developing. In addition, a user's unique requirements often necessitate the modification of standard specifications. If, however, the steps for preparing a detailed Needs Statement and thorough Feasibility Analysis have been followed, then it will not be difficult to develop technical specifications.

Each technical specification will consist of three parts: (1) a required design characteristic or performance capability, (2) a measure or level of quality, and (3) a test and inspection procedure. The technical specifications should be developed one requirement at a time. This can be accomplished in five steps:

1. List design characteristics and performance capabilities required.
2. List candidate specifications and their source.
3. Review the intent and effectiveness of each specification.
4. Draft the technical specification.
5. Establish test and inspection procedures.

If the jurisdiction lacks the technical skills to perform these Steps it should consider hiring a consultant to do this work.

Step 1: List Design Characteristics and Performance Capabilities Required

The procurement team should carefully examine the Needs Statement and Feasibility Analysis to uncover specific issues, requirements, and problems that need to be addressed in the technical specifications. For example, the information requirement concerning area of coverage should have been specifically defined in the Needs Statement and Feasibility Analysis. This issue can now be dealt with by developing a series of coverage requirements which specify the project area to be examined, and perhaps the flight line path. The list of information requirements and remote sensing system capabilities defined earlier are to be used as a guide to ensure that the technical specifications are designed in a way which responds to the original problem definition.

Table II-1 identifies many of the significant factors which should be addressed in the technical specifications for each of several remote sensing system components such as aerial surveys, satellite surveys and interpretation and analysis systems.

The subjects listed for specification consideration relate to a composite of requirements that have often been found to be essential for the satisfactory completion of various remote sensing procurements. In general they can either be quantified and therefore measurably related to the technical precision or engineering quality of the data as

> "Not more than 10% of any photograph, or 2-1/2% of the entire project shall be obscured by cloud or dense cloud shadow."

or other specifications can be more subjective, affecting interpretation

TABLE II-1 -- FACTORS FOR CONSIDERATION WHEN PREPARING TECHNICAL SPECIFICATIONS

Considerations for (1) Preparing Aerial Summary, (2) Landsat (or satellite) data, (3) Interpretation/Analysis Systems Specifications*	Specification/Performance Objective			
	Technical/ Engineering Quality	Interpretation Analysis Quality	Data/ Product Quality	Other
Project area	1, 2			
Temperal considerations		1, 2		
Correlation expected		1, 2		
Resolution requirements of the project	1			
Scale of the desired product	1, 2			
Changing the scale of the imagery	1, 2			
Relative internal accuracy of the geometry of a single image	2			
Absolute accuracy of the geometry required for the filling of an image to a defined map projection	1, 2			
Spectral range(s) required	1, 2			
Field work or ground truth requirements		1, 2		

Table II-1 (continued)

	Technical/ Engineering Quality	Interpretation Analysis Quality	Data/ Product Quality	Other
Specific mission constraints	1, 2			
Crabing	1			
Tilt	1			
Flight height	1			
Flight lines	1			
Requirements for stereoscopic coverage	1	1		
Allowable breaks between images	1			
Reflight criteria	1			
Required overlap of images	1, 2			
Contouring criteria	1, 2			
Use of additive color techniques to produce true or false color representations of data from two or more data sets of the same feature or phenomenon		1, 2	1, 2	
Geometric correction for aspect angle compensation	2			
Geometric correction for sensor data distortion	2			

Table II-1 (continued)	Technical/ Engineering Quality	Interpretation Analysis Quality	Data/ Product Quality	Other
Recognize and filter out unwanted data		1, 2		
Enhance data or imagery to improve display or analysis		1, 2	1, 2	
Mosaicking or merging of two or more images into a larger format			1, 2	
Registration so that other images or data formats maintain coincidence			1, 2	
Multispectral comparison of two or more sensor records of the same feature or phenomenon for different spectral bands.		1, 2		
Reduce data band width with no information bias.		1, 2		
Minimum cloud cover	1, 2			
General image quality			1, 2	
Physical quality of the product			1, 2	
Classification or interpretation accuracy	1, 2			
Required calibration of remote sensing systems	1			
Annotation requirements of the product			1, 2	

Table II-1 (continued)

	Technical/ Engineering Quality	Interpretation Analysis Quality	Data/ Product Quality	Other
General film characteristics			1	
Required indexes of imagery on data			1, 2	
Ownership and use of the data/ product				1, 2
Final acceptance of product	1, 2, 3	1, 2, 3,	1, 2, 3	
Hardware requirements	1, 3			
Capabiltiy to support other systems	3			
Capability of system to be expanded or upgraded	3			
Software requirements	3			
Graphic function and/or data display requirements	3			
Nongraphic function and/or data display requirements	3			
Data input requirements	3			
System maintenance				1
Training				1, 2, 3

*Prior to writing specifications, or conducting negotiations, the pertinent guidelines should be reviewed and when necessary, be changed or amended to ensure satisfaction of any special needs.

or analysis quality, or the quality of the data product, i.e.,

> "All negatives and prints shall be clean, free from chemical or other stains, and processed for the maximum resolution and the fullest tone scale possible."

The latter type of specification, while necessary, is much more difficult to check and therefore rejection and/or revision should be specified to be at the discretion of the purchaser at no increase in price.

Step 2: List Candidate Specifications and Their Sources

Existing technical specifications written by other jurisdictions used to meet similar needs can be helpful in developing your remote sensing specifications. However, care should be exercised in the way these existing technical specifications are used. Generally, these specifications cannot be directly transferred from one procurement to another.

With these cautionary remarks in mind, the procurement team should:

- Examine the jurisdiction's own files for suitable specifications.
- Solicit help from other jurisdictions identified in the Needs Statement as having experience with remote sensing procurements.
- Contact organizations having expertise in remote sensing (refer to Table I-2 and the Appendix for these sources).
- Contact the technical representatives (not sales representatives) of the remote sensing firms listed in the Remote Sensing Directory
- Examine the model specifications used or developed by government agencies and private organizations.

  For examples of model specifications refer to the following publications:

- o USDA Aerial Photography Specifications
  USDA-AP-300
  Agricultural Stabalization and Conservation Service
  Aerial Photography Field Office
  2222 West 2300 South
  Salt Lake City, Utah 84119

- o Computer Assisted Mapping and Records Activity System Manual (CAMRAS)
  "Aerial Photography for Photogrammetric Mapping";
  "Procurement Specification Interactive Graphics System";
  "File Format for Data Exchange Between Graphic Data Bases."
  Utilization and Coordination Council and
  The APWA Research Foundation
  American Public Works Association
  1313 East 60th Street
  Chicago, Illinois 60637

The procurement team may also wish to discuss the jurisdiction's specific functional and performance needs with technical representatives (not sales representatives) of potential contractors. The purpose of these talks is threefold:

- o To gather state-of-the-art information unobtainable from previous procurements;
- o To learn where previously-used specifications are too restrictive and how to improve them; and
- o To develop evaluation criteria and a tentative contract schedule.

However, a word of caution is necessary. In order to avoid lawsuits from potential contractors claiming that the specifications were written to favor one contractor over others, discussions with potential contractors should be limited to technical factors; why they are important, and how they should be evaluated. Also, for added protection, detailed notes of these discussions should be taken and discussions must not focus on particular products or services offered by a particular contractor.

Finally, the practice of issuing a Request for Proposals based on preliminary specifications with the intention of cancelling the solicitation once proposals are received should never be used because it costs respondents significant amounts of time and money, and these costs are eventually reflected in higher-priced bids or proposals.

Step 3: Review the Intent and Effectiveness of Each Specification

The procurement team should carefully organize the assembled candidate's specifications in a manner highlighting the intent and effect of each requirement, thereby facilitating the selection of essential and nonessential but desirable requirements. One approach, illustrated in Figure II-1 is to prepare a separate 5" x 9" card for each requirement included among the candidate specifications. Each such card should record the requirement, identify its source and characterize it's key feature. After organizing the requirements cards according to specific characteristics or capabilities, the procurement team should compare the intended effect of each requirement with the objectives of the procurement (documented in the Needs Statement and Feasibility Study Report), and review the effectiveness of each requirement. These two comparisons should enable the procurement team to distinguish between essential, nonessential but desirable, and undesirable requirements by highlighting those that produce desired effects. The conclusions -- essential, nonessential but desirable, or undesirable -- must then be noted on the corresponding requirements card.

(Front)

REQUIREMENTS CARD

Requirement: "Negatives made with the optical axis of the camera in a vertical position are desired. Tilt (departure from the vertical) of any negative exceeding four (4) degrees or relative tilt between any two successive negatives exceeding six (6) degrees may be cause for rejection.

Source: "Aerial Photography Specifications," 1979, U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service. Aerial Photography Field Office, 2222 West 2300 South, Salt Lake City, Utan 84119.

Characteristic/Capability: Accuracy

Effect: It is intended to control the degree of geometric fidelity in the image.

Significance: Essential

Figure II-1 (Sample Requirements Card)

Finally, the procurement team should analyze these conclusions from an operational and procurement perspective by addressing the following questions to each essential or nonessential but desirable requirement:

- Is this requirement really essential, or is it merely desirable (for essential requirement)?
- Is this requirement really only desirable, or is it a truly nonessential requirement (for nonessential but desirable requirement)?
- Does this requirement overstate the minimum requirement and thereby raise the cost of the resultant product or service?
- Does this requirement understate the minimum requirement and thereby invite bids or proposals that will fail to resolve the problem?

Step 4: Draft the Technical Specifications

The procurement team should now be ready to draft the technical specifications, requirement by requirement. Team members should begin by separating the essential and nonessential requirements, and dividing both groups into subgroups of specific characteristics or capabilities. Next, the team should review the exact language used to describe each of the requirements and the relative effectiveness of these requirements. Based upon the language and relative effectiveness, the procurement team should then formulate a new requirement appropriate for the present procurement. Finally, this same process should be repeated for every subgroup of essential and nonessential but desirable requirements.

If the procurement team is unable to define a measure capable of describing the characteristic or capability embodied in the requirement, then the specification is probably meaningless and should be

evised or eliminated. For example, a close examination of the requirement "all items shall be of first-class workmanship" would disclose that it is meaningless because, as it is currently written, the requirement provides no measure capable of distinguishing between first- and second-class workmanship. If, on the other hand, definitive standards for workmanship are available, they could be written into the requirement directly.

The procurement team should keep several principles clearly in mind when formulating specifications. First, each characteristic or capability must be measurable, otherwise the specification is meaningless and it should be revised or eliminated. Secondly, the language and format should be clear, concise, and consistent. Third, the technical content should be comprehensive yet nonrestrictive. Fourth, references to "brand name or equivalent" should be avoided. For example, "The camera for photography will be Wild FC-8, Zeiss RMK-A15-23 or equivalent." Fifth, references to other documents should be minimized. Table II-2 set forth these and other principles.

Step 5: Establish Test and Inspection Procedures

Test and inspection procedures are needed to determine if the product or service conforms to the technical specifications when it is delivered. They must be established at this point in the procurement process in order to provide the procurement team with an opportunity to review or eliminate a requirement if there is no satisfactory way of assuring compliance. In general, these tests fall into the following categories:

- Engineering tests for scale, resolution, registration or geometric correctness.
- Visual inspections of imagery for cloud cover.

TABLE II-2 -- PRINCIPLES OF SPECIFICATION WRITING

- The language used should be clear and simple. Avoid vague and ambiguous terms and jargon. Use simple sentences and minimize punctuation through careful selection of word order. Standard symbols, abbreviations, and relevant technical terms may be used to clarify and shorten specifications, but only if their meaning has been clearly defined. Include a glossary of technical terms.

- The technical content should be comprehensive, appropriate, and nonrestrictive. All essential information should be included, either directly or by reference to other documents that are attached or known to be possessed by the potential respondents. Every facet of each requirement should be covered by the specifications; potential respondents should not be expected to guess what is required. All support items (e.g., training, maintenance, etc.), all documentation, all dates, and all numbers of items (e.g., people, departments, equipment, documents, etc.) should be listed. Each requirement should be clearly described as essential, or nonessential but desirable. Requirements that unreasonably restrict competition should be avoided. Requirements should not be repeated, but if they must be, they should be presented in the same format and context throughout the document.

- References to "brand name or equivalent" should be avoided unless the dollar value of the required product or service does not justify the cost of preparing a proper specification. A "brand name or equivalent" clause should never be used when there is only one brand of product that can meet the requirement; in this case, the specific brand must be named and the procurement team must clearly establish why no other product can satisfy the government's need. Furthermore, when such a clause is used, the manufacturer's name and the model name, type number, and catalog number should be provided for all brand-name products known to satisfy the requirement, as well as the salient characteristics of these products.

- References to other documents must be carefully made, and only when appropriate. These references should be specifically and clearly applicable to the specifications, as with requirements or tests that are adequately described elsehwere, and they must be readily available. They should be reduced to the point where the reader need only go to the referenced document(s) to find the necessary data, without searching through a trail of references. The contents of the specifications should not conflict in any way with the provisions of the referenced documents unless special exceptions to those requirements are desirable and so stipulated, or the applicability of the conflicting portion of the referenced document is clearly circumscribed. Documents should not be referenced unless the quality or level of detail of their contents matches the desired quality or level of detail of the specifications; "over-specification" can be wasteful in terms of time and money. Finally, references should be made to an entire document only after all its provisions are clearly understood to be required. Portions of documents should be referenced by title, section number, or some other well-defined designation, not by paragraph number.

Table II-2 (continued)

- Certain words and phrases commonly used in specification writing should be adopted. Documents should be referenced using the phrases "conforming to ...," "as specified in ...," or "in accordance with ....". Requirements previously stated in the specifications should be referenced by the phrase "as specified herein," provided that the referenced requirement is obvious or not difficult to find, or by identifying the exact location of the referenced statement (e.g., as specified in section II.B.a on page 11 of this RFP). Limitations should be stated positively (e.g., "The height shall be no greater than..."). Finally, the words "shall," "will," "should," and "may" have different meanings and should be used accordingly. "Shall" is used to express mandatory requirements, "should" and "may" are used for nonmandatory requirements. "Will" is used as a declaration of purpose on the part of the purchaser, or wherever the simple future tense is desired.

- The format and layout of the specification document should be easy to read and follow, and it should be consistent throughout the document. Paragraphs should have underlined titles accurately reflecting their contents. Figures (i.e., pictures or graphs forming an integral part of the specification) and tables (i.e., displays of data in lines and columns) should be applicable to and consistent with the content of their associated paragraph, and they should follow or be placed within that paragraph. However, if these are so numerous that doing this would be confusing or inconvenient, they may be placed at the end of the specifications before any appendixes or indexes. Figures and tables should be uncomplicated, and used only when information can be presented more clearly in pictorial or tabular form than in the text. The textual references to them, therefore, should be sufficiently detailed to indicate their purpose and relevancy. Numbered, dated drawings referenced in the text are not figures and should therefore be listed in a separate section instead of physically incorporated into the specifications. Figures, tables, and drawings should each be titled and numbered consecutively with arabic numerals, as in this Technical Guide.

- o Visual inspection of film, overlays, and paper images for gross photographic quality.
- o Microscopic inspection of film and images for photographic quality.
- o Densitometric verification of gray scale range and distribution.
- o Comparison of remote sensing data with historic information.
- o Field (ground truth) verification of interpretations and identifications of features or phenomena.
- o Use of established ground control points to verify identifications and interpretations of features or phenomena.
- o Comparison of interpretive overlays with established base maps as guide.
- o Performance tests for software.
- o Engineering tests for hardware.

Since many of these tests require specialized photogrammetric procedures and knowledge, those jurisdictions without in-house capabilities will have to resort to third party consulting evaluations.

In establishing test or inspection procedures, the procurement team should attempt to balance the need for simplicity (to minimize measurement costs) against the need for precision. Since the appropriate degree of precision varies with each requirement, the procurement team should carefully review the purpose and effect of a particular requirement before establishing corresponding test or inspection procedures. At this point, the team should contact some of the organizations with experience in developing remote sensing related specifications for information on standard test or inspection procedures. The procurement team should then document any desired test or quality control procedure, describing:

- The purpose of the procedure.
- The measure used to define the design characteristic or performance result.
- The actual test or inspection procedure.
- The qualifications required for persons conducting the test or inspection.
- Any special equipment or instruments required to conduct the test or inspection.
- Estimated cost of the test or inspection procedure.

Last, the procurement team should also consider using warranty clauses expressing that the bidder unconditionally warrants the product or service as being free from defects and/or is capable of being used to perform the specified task or requiring a performance bond in lieu of (often) time consuming and expensive test and inspection procedures.

TASK 5: DEVELOP CONTRACTUAL REQUIREMENTS

Contractual requirements describe the terms and conditions under which the jurisdiction will purchase a product or service. They differ from technical requirements in their focus on such issues as how, when, and in what condition the product or service is to be delivered; how much and what kind of contract support is promised by the government; what happens in the event of disputes or failure of the contractor to live up to the terms and conditions of the contract; and other issues that do not directly affect the product or service. By taking the initiative and developing the jurisdiction's contractual requirements, instead of waiting for the contractor to offer his standard contract, the jurisdiction gains the following benefits:

- The contractor's responses to the contractual requirements provide an early insight into his position and willingness to negotiate.
- The contractual requirements highlight those areas of a remote sensing procurement requiring careful attention by management, operations, and technical personnel.
- The contractual requirements clearly show the government's intent in the event of future contractual problems.
- The contractual requirements alert top management to the risks of potential losses the government may be taking.

The primary responsibility for developing contractual specifications rests with the procurement specialist and a lawyer, supported by other members of the procurement team. Together, they should complete the following three steps:

1. Select an appropriate contract type.
2. Select the essential contract clauses.
3. Formulate contractual specifications.

Step 1: Select an Appropriate Contract Type

There are two basic types of contracts -- fixed-price contracts and cost-reimbursable contracts -- and both types have several variations. The appropriate contract type depends upon the amount of risk or uncertainty associated with meeting the technical requirements. Fixed-price contracts predominate in state and local governments, they should be used whenever the risk or uncertainty is known and manageable. The various fixed-price contracts include firm-fixed-price contracts and fixed-price contracts with escalation, incentive, or redetermination clauses. Cost-reimbursable contracts should be used whenever either performance or cost is highly uncertain, as in research and development contracts. Acceptable variations call for reimbursement for all costs with provision for a fixed, incentive, or award fee. Two other contract types -- time and materials contracts and labor hour contracts -- are not usually used in nonstandard procurement efforts.

Table II-3 describes these major contract types, all of which should have a ceiling price. The procurement team should become familiar with these options and, after studying the business and technical factors influencing contract performance, select the most appropriate contract type.

The selection of an inappropriate contract type is likely to reduce the number of eligible respondents, increase costs, or increase the risks that technical specifications will not be met. If a cost-reimbursable contract seems warranted, but fixed price is preferred, then the procurement team should consider a demonstration-test project or phasing of the procurement to reduce risks. Modifications to the

TABLE II-3 -- CONTRACT TYPES

FIXED PRICE CONTRACTS should be used in procurements where firm specifications and a definitive statement of work exist. In these instances, risks will be managable and the contractor should be willing to assume all, or a large portion, of the risk. The contractor's cost management will determine how much profit or loss will result.

- Firm Fixed Price (FFP). This type of contract pays a contractor a firm, fixed price upon the delivery or completion of services, regardless of the costs involved. The contract price is changed only if the scope of work is changed. All risks are placed on the contractor because his management of costs determines the amount of profit or loss he will attain. Therefore, the contractor has a maximum, positive incentive to manage the work efficiently. This type of contract is best suited for fixed work scopes with firm specifications and set rates of performance because the absence of uncertainty minimizes the likelihood of danger.

- Fixed Price, with Escalation (FPE). This type of contract provides for the upward and downward revision of the stated contract price upon the occurrence of certain contingencies which are specifically defined in the contract. It should be used where prices for certain materials or items are highly unstable industrywide, or when they seem to be temporarily inflated or subject to future reductions. The contractor bears all risks except those associated with uncontrollable price changes for specified items and, therefore, still has a maximum positive incentive to manage the work efficiently. A ceiling price should be established in all FPE contracts to protect the government against unlimited escalation of the contract price. In essence, once this ceiling is reached, the contract reverts to an FFP contract.

- Fixed Price Incentive (FPI). This type of contract provides for risk sharing between the contractor and government while still providing the contractor with a positive incentive to manage the work efficiently. The contract establishes target cost, target profit, ceiling price, and formula that transforms these variables and the actual cost into a final price. This formula typically establishes the final price as the sum of: (1) the target cost, the target profit, and a percentage of all costs in excess of the target cost; or (2) the actual cost, the target profit, and a percentage of the difference between actual and target costs, depending upon whether the actual cost is more than or less than the target cost. Moreover, these percentages (or sharing ratios) may also vary according to how well cost, delivery, reliability, or other stated objectives are met. In order to protect the government, a ceiling price (cost plus profit) is also fixed at a certain percent above the target price (target cost plus target profit). In essence, the contractor receives no additional money once the ceiling price is reached.

Table II-3 (continued)

This FPI contract is more specifically known as fixed price incentive, fixed target (FPIF). A variation, termed the fixed price incentive, successive targets (FPIS) contract, establishes an initial target cost, initial target profit, ceiling price, a formula and time for fixing a firm target profit, and a formula for fixing the final price. When the designated time is reached, a firm target cost is negotiated and the formula is used to derive a firm target profit. Once firm target costs and profits have been established, the FPIS contract reverts to an FPIF contract. Thus, once the work is completed and the actual cost is known, the second formula is used to derive the final contract price.

- Fixed Price Redeterminable (FPR). This type of contract provides for a different kind of risk sharing. The contract establishes: (1) a firm fixed price for an initial period of contract deliverables or performance, (2) one or more times at which the contract price is redetermined and, usually (3) a price ceiling. This prospective price redetermination is most appropriate where a firm fixed price can be negotiated for an initial period, but not for subsequent periods of contract performance. A variation, termed retroactive price redetermination, should be used only when an FFP contract cannot be negotiated and the amount involved is so small or time is so short as to preclude any other contract type. While there is some incentive for cost control under a prospective price redetermination contract, there is little if any incentive under a retroactive price redetermination contract.

COST-REIMBURSEMENT CONTRACTS should be used where the risk or the scope of work is indefinable, and where valid estimates of the work and its related costs cannot be made. The government agrees to reimburse the contractor for all allowable costs expended, up to a specified ceiling cost. The government must have a standard and a method for validating what is and what is not allowable. In certain cases, the government may wish to pay for costs only (R&D contracts with nonprofit organizations), or share the costs with the contractor according to some negotiated formula. Cost-Plus-a-Percentage of Cost (CPPC) contracts, in which the fee is determined as a percentage of dollars spent, are at best inadvisable, and frequently illegal.

- Cost-Plus-Fixed Fee (CPFF). This type of contract pays the contractor all allowable costs plus a fixed fee, limited only by the ceiling price. Because the fee does not vary in relation to the contractor's ability to control costs, there is little incentive for the contractor to control costs; nearly all the risk is borne by the government. The fee is changed only if the scope of work is changed and/or the contract is terminated prior to its completion. Use of this contract type should therefore be limited to research and development work and other instances where the level of effort cannot be equated to an incentive base.

TABLE II-3 (continued)

- Cost-Plus-Incentive-Fee (CPIF). This type of contract is similar to the FPI contract because it offers the contractor a higher fee, based upon a proportional sharing formula, when he achieves lower costs or higher performance than initially estimated; and a lower fee if the costs are exceeded or if performance fails to reach target levels. The major difference is that a maximum fee and a minimum fee are also set for the CPIF contract, thereby limiting the contractor's management incentive. Also, unlike the FPI contract, the minimum fee defines the least amount that the contractor can receive regardless of his cost expenditures, provided that the cost ceiling is not exceeded without the buyer's prior permission. This contract type is most suitable for development and test procurements where cost estimates may not be dependable.

- Cost-Plus-Award-Fee (CPAF). This type of contract also provides the contractor with some incentive to control costs or to meet other specified performance objectives. Unlike the CPIF contract, however, finite measurements of performance are unnecessary. Instead, the contract establishes a two-part fee: (1) a fixed fee that does not vary with performance, and (2) an award fee that is periodically granted during performance of the contract to reward excellence in contract performance in such areas as quality, timeliness, ingenuity, and cost control. The award fee, which may be earned in whole or in part, is based on a unilateral subjective evaluation of the contractor's performance by the government, using criteria set forth in the contract. This type of contract is used primarily for research, development, testing, and management of government installations where a cost-reimbursement contract type is necessary but where target costs and fee adjustment formulas cannot be accurately determined.

SPECIAL CONTRACT TYPES. A third group of contract types are neither fixed-price nor cost-reimbursable contracts. Moreover, they usually are not applicable to nonstandard procurements.

- Time and Materials Contract. This type of contract provides payment for supplies and services based upon the actual cost of the materials and the number of direct labor hours required for performance. The contract sets forth hourly labor rates (e.g., $12.50 per hour), including profit and overhead for various classes of labor; a maximum allowable cost for materials, including all handling costs; and a ceiling price. This contract type is most useful for procuring repair and maintenance services.

Table II-3 (continued)

- Labor Hour Contract. This type of contract is a variation of the time and materials contract, differing only in that it does not provide payment for materials. It is most useful for any personal services contract (i.e., design, drafting, engineering, etc.); but, again, a ceiling price and some method of control over the quality of the work and the perserverance of the contractor are necessary.

technical specifications may also offer opportunities to reduce risks.

Fixed-price contracts are most appropriate when the risks associated with a remote sensing project are limited. Aerial photo surveys, mapping and manual photo interpretation with few unique requirements are often appropriate for fixed-price contracts. In general, applications for which there is a great deal of experience, and products with catalogue prices, routine labor requirements, and few potential contingencies or problems also fall into this class. However, many other remote sensing procurements involving innovative techniques, new applications, large amounts of personnel or computer time, and hardware or software modifications may require cost-reimbursable contracts.

Step 2: Select the Essential Contract Clauses

Like technical requirements, contractual requirements should be developed one clause at a time. While most jurisdictions generally have one or more standard contracts or contract "boilerplate" that they use in most procurements, the procurement team should avoid using these contract terms and conditions without first examining the need for each clause. The procurement team should also review other contracts used by the jurisdiction on previous occasions, contracts used by other jurisdictions to purchase or lease similar products or services, and other documents on contract terms and conditions in order to identify contract clauses that may be relevant to the current procurement. However, team members should keep in mind that each nonessential clause included in the final contract will probably increase the cost of the procurement.

The procurement team should look to the purchasing department for copies of contracts used in past procurements. Copies of contracts used by other jurisdictions should be available directly from those jurisdictions' purchasing departments, or indirectly from such organizations as the National Institute of Government Purchasing, Inc. and the National Association of State Purchasing Officials. The following two documents also provide additional general information on contract clauses:

- Data Processing Contracts: Structure, Contents, and Negotiation, by Dick H. Brandon and Sidney Segelstein, Esq. (New York: Van Nostrand Reinhold Co., 1976).
- "Terms and Conditions Applicable to Contracts with Outside Consultants," by Norman P. Yarosh (Minneapolis: Office of the City Coordinator, 1977).

Table II-4, Contractual Provisions Checklist, draws heavily from these two documents.

In reviewing specific contract terms and conditions, the procurement team should examine both their purpose and effectiveness. Some clauses will be mandated by law or regulation, some will be required to implement government policies, some will be necessary to protect the government's interests, and some will be unnecessary. All unnecessary clauses must be eliminated from further consideration, even if they are part of standard government contracts.

Step 3: Formulate Contractual Specifications

The procurement team is now ready to establish its position on each selected clause. This can be done by either writing the clause exactly as the procurement team would like it to appear in the final

TABLE II-4 -- CONTRACTUAL PROVISIONS CHECKLIST

_____ Definition of Terms -- To specify the precise meaning of technical and other special terms used in the contract.

_____ Scope of Work -- To delineate the role of the contractor and specify the products and/or services to be provided.

_____ Statement of Work -- To describe, in detail, the tasks and steps that the contractor must accomplish, and the specific deliverables due at each stage.

_____ System Performance -- To define, from the user's perspective, the types of functions that the aggregate of all hardware and software must meet, and the constraints within which the system must operate.

_____ Term of Performance -- To specify the starting date and duration of the contract (i.e., when work should be started and completed), and any provisions for automatically extending the contractual period.

_____ Assignment of Key Personnel -- To ensure that particular members of a contractor's staff conduct specific portions of the contractual work effort.

_____ Technical Direction -- To authorize a government technical representative to give direction to the contractor's work effort, and to specify any limitation on this authority.

_____ Contract Administration -- To designate responsibility for supervising the performance of the contractor, and for sending and receiving official communications between the government and contractor, via a contract administrator.

_____ Official Notice -- To state explicitly what constitutes official notice from one party to the other.

_____ Status Reports -- To require formal written status reports from the contractor, and to specify the content of these reports.

_____ Delivery -- To describe the delivery schedule for all project deliverables.

_____ Location of Work -- To explicitly state whether the contractor must provide personnel at the government's offices on a full-time or intermittent basis.

_____ Performance Guarantees -- To describe a mechanism for measuring reliability which will ensure that equipment will meet the necessary standards without excessive interruption for maintenance and repair, and to provide the user with the right to have equipment replaced when it consistently fails to meet these reliability standards.

Table II-4 (continued)

_____	Acceptance Tests -- To describe the test procedures and performance criteria that are to be used to determine the acceptability of all project deliverables.
_____	Recision During Warranty Period -- To provide a means for terminating the contract, returning products, and receiving a refund whenever a product fails to meet functional specifications during the warranty period and is not, or cannot be, repaired.
_____	Warranty of Used Equipment -- To describe and guarantee the condition of all used equipment that is provided the government.
_____	Price -- To describe any price adjustment formulas or procedures, and to define all allowable costs.
_____	Invoices and Payment -- To specify the method of paying the contractor. Provision for prepayment of a deferred price whenever it is to the government's advantage to do so is highly recommended.
_____	Audit and Records -- To provide for the maintenance and governmental examination of the contractor's cost records, and for their preservation for a period of time after completion or termination of the contract.
_____	Work Hours -- To resolve matters pertaining to working hours and holidays for contractor personnel working in the government's offices.
_____	Notice Regarding Delays -- To require notification whenever the contractor encounters or anticipates difficulties in meeting performance or delivery commitments.
_____	Termination -- To specify the circumstances under which the contract may be terminated, and the procedure for termination. Provision for unilateral termination by the government, at any stage of the contract, is highly recommended.
_____	Disputes -- To specify the procedure to be followed by the contractor and government in resolving any disputes that might arise under the terms and conditions of the contract. Provision for arbitration is highly recommended.
_____	Excusable Failures -- To specify the circumstances under which the contractor will not be held liable for performance failures.
_____	Penalties, Liquidated Damages -- To emphasize the importance of specific performance or delivery requirements by imposing financial penalties on the contractor for a failure to meet these requirements. The penalties would be proportional to the extent of the delays or performance failures.

Table II-4 (continued)

_____	Employment Disclaimer -- To avoid the obligations and liabilities of an employer to the contractor's personnel by adding a disclaimer to the contract that declares the contractor to be an independent contractor, not a government employee.
_____	Publications, Patents, Copyrights -- To define ownership, control, and use of all publications and other proprietary products developed or used under the contract.

contract, or by defining the objective(s) to be served by the clause. As a general rule, it is desirable to use the actual words contemplated. All words with special meanings should be underlined in the text and defined in a separate section of the contract document.

The procurement team should be guided by this effort by the specific terminology used in previous contracts; by Brandon and Segelstein's Data Processing Contracts: Structure, Contents, and Negotiations; and by Yarosh's "Terms and Conditions Applicable to Contracts with Outside Consultants" (the full citations appear above). CAUTION -- the examples provided in both of these references are not intended, and should not be used, as substitutes for actual legal assistance in drawing up contracts.

Once specifications are formulated for each essential contractual requirement, they must be reviewed by the jurisdiction's legal counsel.

TASK 6: ESTABLISH EVALUATION CRITERIA

Evaluation factors are attributes of a bid or proposal, or of its offeror, that influence the selection of one bid or proposal over another. Evaluation criteria are the specific standards or measures used to make this selection.

Evaluation criteria serve four primary functions. First, they define the minimum qualifications that potential contractors must meet if they wish to be considered for the contract award. Second, they measure the degree to which bids or proposals satisfy the technical and contractual specifications. Third, they define other technical, managerial, business, and cost considerations that influence the eventual contract award decision. Fourth, they help potential contractor prepare more responsive bids or proposals.

The entire procurement team should participate in establishing evaluation criteria. The task involves four steps:

1. Establish the screening criteria.
2. Define other technical, managerial, and business criteria.
3. Define the cost criterion.
4. Establish priorities among these evaluation criteria.

The procurement team may also wish to develop a detailed evaluation plan at this time. This plan -- including evaluation and weighting techniques, and the corresponding forms and instructions -- must be developed before any bids or proposals are opened. Nevertheless, this task is limited to establishing the evaluation criteria; for guidance on how to develop appropriate evaluation forms, refer to Task 9 in Section IV.

Step 1: Establish the Screening Criteria

Screening criteria are used to eliminate unqualified contractors and unacceptable bids or proposals from detailed consideration. This screening process helps to minimize the amount of time and effort spent on evaluating bids or proposals. No screening process is perfect, however, and the savings in evaluation costs attributable to a screening process can be easily lost to higher prices, reduced effectiveness, or delayed acquisition if the best bid or proposals is inadvertently eliminated from detailed consideration.

The procurement team must, therefore, limit the screening criteria to the essential technical requirements of the product or service, and the minimum qualifications of a potential contractor or supplier. Bids or proposals must meet each essential requirement or be eliminated from further consideration. The same holds for the potential contractor or supplier -- either meet each minimum qualification or be eliminated from further consideration. Table II-5 lists several potential screening criteria.

Step 2: Define Detailed Technical, Managerial, and Business Criteria

The procurement team also needs to define detailed criteria for ranking the remaining bids or proposals according to their degree of acceptability relative to specific technical, managerial, and business factors. Evaluation criteria should be defined for such technical factors as the level of understanding exhibited by a bid or proposal, its responsiveness to the technical and contractual requirements, the appropriateness of the overall technical approach or methodology, and

TABLE II-5 -- POTENTIAL SCREENING CRITERIA

A. Essential Technical Requirements -- list them all, including general responsiveness to the need and scope.

B. Minimum Contractor or Supplier Qualifications.

1. Experience.

a. Prior work of a similar functional nature.
b. Prior responsibility for projects of a similar size, dollar cost, or scope.
c. Prior work for other jurisdictions of a similar size and type.
d. Prior work for the state or locality.
e. Prior successes in previous work experiences.

2. Personnel Availability.

a. Individuals with appropriate educational backgrounds.
b. Individuals with appropriate professional, technical, or managerial experience in person years.
c. Individuals affiliated with appropriate professional societies.

3. Special Equipment and Facilities.

4. Stability.

a. Sufficient history (years) of doing business in the field.
b. Sufficient size in terms of the number of employees and the dollar sales of the business.
c. Tenure of managerial and technical staff.

5. Residency Requirements.

a. Existence of a permanent office in the state or locality.
b. Availability of professionals with state registration.

6. Potential Conflicts of Interest.

C. Completeness -- provision of all required information.

TABLE II-6 -- EVALUATION CRITERIA CHECKLIST

I. TECHNICAL FACTORS

A. Understanding of the work to be done.

1. Awareness of key problem areas, as opposed to symptoms.

2. Awareness of how local conditions and constraints, and human and environmental factors affect resolution of the problem.

3. Awareness of what other jurisdictions and organizations have done under similar circumstances.

4. Comprehension of the procurement objectives.

5. Awareness of the need for coordination between the various affected parties.

B. Responsiveness to the solicitation.

1. Compliance with the specifications.

a. Essential requirements.
b. Nonessential but desirable features or characteristics.
c. Contractual terms and conditions.
d. Schedule and delivery requirements.
e. Budgetary requirements.

2. Adequacy of the proposal's definition of scope.

a. Addresses all major system elements.
b. Differentiates between relatively hard and easy requirements.
c. Clearly defines expected results.

3. Thoroughness and completeness.

a. All requested data are provided.
b. Presentation is well organized, clear, concise, and legible.
c. Material is pertinent and significant, not irrelevant.

C. Appropriateness of the overall technical approach or methodology.

1. Potential for design excellence.

a. Soundness.
b. Simplicity.
c. Compatibility with the local environment -- absence of cookbook applications.

Table II-6 (continued)

1. Potential for design excellence (Continued).

   d. Flexibility
   e. Awareness of the state-of-the-art.

2. Reliability and maintainability.

   a. Uses proven techniques and components.
   b. Based upon "worst-case" analysis.
   c. Considers the need for future system modifications.
   d. Incorporates system test and maintenance features.

D. Adequacy of the workplan.

1. Adequacy of task and subtask descriptions.

   a. Clearly describes what the contractor will and will not do in each task or subtask.
   b. Clearly describes the types of personnel, equipment, facilities, and materials needed for each task or subtask.
   c. Estimates the amount of manpower, equipment, facilities, and materials required to accomplish each task and subtask.
   d. Describes the relative timing of each task and subtask.
   e. Describes the output expected from each task or subtask, including outlines of written documents.
   f. Demonstrates an awareness of the work to be done, responsibilities, and difficulties with each task or subtask.
   g. Underscores the key decision points.

2. Reasonableness of tasks and subtasks.

   a. Reasonableness of manpower, equipment, facility, and materials estimates.
   b. Reasonableness of scheduling sequence and time allocations.
   c. Appropriateness of the relative weights given to each task and subtask.
   d. Appropriateness of the relative workloads placed on the government and contractor.
   e. Probability of successfully executing the tasks and subtasks within the local working environment.

3. Adequacy of mechanisms for reviewing, evaluating, reporting, and controlling progress and levels of effort.

Table II-6 (continued)

II. MANAGERIAL FACTORS

A. Capability -- capacity to perform the required work within the stated constraints.

1. Relevancy of previous work experience.

a. Familiarity with work of a similar functional nature.
b. Familiarity with projects of a similar size, dollar cost, or scope.
c. Familiarity with governmental practices and procedures.
d. Familiarity with local conditions and practices.

2. Relevancy of personnel qualifications.

a. Number of personnel with the appropriate educational and experience backgrounds, in all the needed disciplines or skill areas.

(1) In-house personnel.
(2) Normally used consultants or subcontractors.
(3) Special consultants or subcontractors.

b. Currency of expertise in specialized areas.

(1) References to special research or studies.
(2) Presence at recent conferences or symposiums.

c. Quality of personnel as indicated by their salary scales.
d. Ability to sustain the loss of key personnel.

3. Adequacy of equipment and facilities.

a. Current capacities and reserves.
b. Commitments to others.
c. Ease of obtaining additional equipment or facilities.

B. Adequacy of management plan.

1. Adequacy of organizational structure.

a. Clearly establishes a single individual with ultimate project responsibility.
b. Clearly provides this individual with the authority necessary to manage and control the project.
c. Clearly differentiates between management and operational responsibilities for each task.

Table II-6 (continued)

1. Adequacy of organizational structure (Continued).

   d. Clearly defines the relationship between the contractor and government.
   e. Clearly exhibits evidence of top management backing for the project.

2. Competence of key personnel assigned to the project.

   a. Project management experience of project officer.
   b. Availability of specific personnel -- with appropriate backgrounds and skills -- for specific tasks.

      (1) Consider current and projected workloads.
      (2) Consider priorities among different projects.

   c. Experience of personnel working as a team.

C. Compatibility with the user.

1. Availability for and participation in meetings.

   a. With neighborhood groups.
   b. With the user agency or other governmental committees.

2. Ability to communicate with laymen.

   a. Oral communication skills.
   b. Visual communication skills.
   c. Written communication skills.

3. Craftsmanship, orderliness, and thoroughness, as displayed through presentations.

4. Character.

   a. Sincerity.
   b. Currency of information.
   c. Willingness to synthesize ideas with those of others.
   d. Ability to achieve rapport with neighborhood groups and government representatives.
   e. Ability to inspire confidence.

5. Enthusiasm for or interest in the project.

   a. Indicated by pleasure in discussing the proposed project.
   b. Indicated by references to specific problems and advantages.

Table II-6 (continued)

5. Enthusiasm for or interest in the project (Continued)

   c. Indicated by the submittal of additional material.
   d. Indicated by a real need for the work.
   e. Indicated by placement of project authority in the firm's top management.

6. Willingness to share information.

   a. Reservations about disclosure of information.
   b. Reservations about copyright ownership or use.
   c. Reservations about patent ownership or use.

7. Responsiveness to questions raised during the evaluation phase.

III. OTHER BUSINESS FACTORS

A. Responsibility and trustworthiness — record of past performance as determined by checking references from previous clients.

1. Demonstrated management ability.

   a. Adherence to delivery schedules.
   b. Adherence to labor and material estimates.
   c. Adherence to cost estimates.

2. Attitude toward correcting problems.

   a. Adequacy of notification of potential problems.
   b. Acceptance of responsibility for correcting problems.
   c. Promptness.
   d. Responsiveness in emergencies.
   e. Reliance upon own staff, not the client's, to solve problems.
   f. Willingness to accept suggestions.

3. Quality of work.

   a. Compliance with requirements.
   b. Responsiveness to functional needs.
   c. Freshness of approach to each new project as indicated by originality and creativity versus similarity of solutions.
   d. User satisfaction.
   e. Appearance.

4. Character.

   a. Flexibility — ability to adapt to changes.

Table II-6 (continued)

4. Character (Continued).

   b. Availability for work with neighborhood groups and government representatives.
   c. Availability of principals for important decisions.
   d. Availability of principals, compared to promises.
   e. Record as an arbiter.

      (1) Competence in document interpretation.
      (2) Fairness in dispute settlements.
      (3) Familiarity with documents and law.

5. Overall recommendation.

   a. Degree of recommendation for similar projects.
   b. Degree of recommendation for any project.

B. Reputation.

1. Relevancy of past awards and honors.

2. Adequacy of general reputation regarding quality of work.

C. Stability of the firm — general corporate condition.

1. Organizational condition.

   a. Quality of top management.
   b. Length of time in the field.
   c. Extent of turnover in personnel.

2. Sufficiency of financial resources.

   a. Liquidity

      (1) Quick ratio.
      (2) Current ratio.

   b. Credit standing.
   c. Ability to raise funds — adequacy of net worth.

D. Compliance with laws and ordinances.

1. Affirmative action experience.

2. Set-aside programs for qualified firms lacking government experience.

Table II-6 (continued)

3. Geographical preferences.

   a. Presence of a permanent office nearby.
   b. Willingness to associate with a local firm.

4. Diversity — relevancy of prior work experience.

   a. Preference for firms with no current and little prior work from the jurisdiction.
   b. Preference for firms that have performed above average or outstanding work for the jurisdiction in the past.

5. Affiliation with professional societies.

6. Potential for conflicts of interest.

the completeness and reasonableness of the proposed work plan. Evaluation criteria should also be defined for such managerial factors as the prospective contractor or supplier's capability and capacity to perform the required work as measured by his work experience, personal qualifications, equipment, and facilities; the adequacy of his management plan; and the degree to which the government and the prospective contractor or supplier can work together harmoniously. Finally, the procurement team should define evaluation criteria that reflect other business factors such as the prospective contractor or supplier's responsibility, trustworthiness, reputation, stability, and compliance with laws and regulations.

The procurement team must use restraint in establishing these evaluation criteria, limiting itself to truly important factors that affect the item's utility. For a comprehensive listing of potential evaluation factors, refer to Table II-6.

Step 3: Define the Cost Criterion

While acquisition cost is an important factor in many procurements, it is not the only cost factor. The true or life-cycle cost associated with a bid or proposal includes: (1) the cost of acquiring the product or service; (2) initial, one-time installation and implementation costs (e.g., the costs of calibrating, adjusting, testing, and documenting the product or service; training personnel; transporting products or personnel; and preparing the site), (3) recurring costs incurred in the operation, maintenance, and management of the product or service; and (4) final, one-time disposal or

FIGURE II-2 -- SAMPLE LIFE-CYCLE COST FORMULA: COMPUTER IMAGE PROCESSING SYSTEM

5-Year Life-Cycle Cost = Acquisition Cost + Installation Cost + 5 x Annual Recurring Cost - 5-Year Salvage Value

Acquisition Cost	= Cost of purchasing professional services + cost of purchasing the equipment.
	= Bid or negotiated price.
Installation Cost	= Cost of training computer operators + freight charges + site preparation costs.
Annual Recurring Cost	= Fully loaded cost of all computer operators and systems analysts + electricity costs + supply costs + maintenance services cost

Notes:
(1) Source selection costs are the same for all respondents, so they are not added in.
(2) The cost of purchasing professional services includes the acquisition cost of all computer software or programs.
(3) Acceptance costs are the same for all respondents, so they are not added in.
(4) Documentation costs are included in the acquisition costs. If there were additional costs for documentation, or if the jurisdiction had to prepare documentation, then additional costs would be added here.
(5) The maintenance services cost covers repair and preventative maintenance including parts, manpower, and transportation. In this case, back-up services are also provided, thus there are no loss of use costs and reserve equipment is maintained at the contractor's cost.
(6) Transportation costs upon resale are picked up by the buyer.

termination costs, including any salvage value. The procurement team must decide which of these cost elements are relevant to the specific procurement.

The procurement team should be guided by one overriding principle in deciding which cost elements are relevant to the specific procurement. That is, the cost of determining the impact of a cost element on bid or proposal costs must be less than the expected savings associated with that cost element. Thus, the relevant cost elements are those that:

- o Account for a significant portion of the total, life-cycle cost;
- o Can be expected to vary, significantly, from one bid or proposal to another; and
- o Can be estimated with reasonable accuracy at a reasonable cost, or are subject to some guarantee or warranty.

Once the cost elements are selected, the procurement team must specify how each cost element is to be quantified and how they are to be combined into a single cost factor. Cost elements are quantified by application of specific cost estimating equations, formulated by the procurement team, or by requiring the bids or proposals to include guaranteed maintenance costs, repurchase prices, etc. Cost elements are combined into a single cost factor by application of a life-cycle cost formula, also formulated by the procurement team. Figure II-2 illustrates one such formula for computer image processing system procurements.

For additional information on life-cycle costing, refer to the Life-Cycle Costing Workbook, prepared by the Value Management Division

of the Federal Supply Service. Copies may be obtained by contacting:

- Value Management Division - FCV
  Federal Supply Service
  General Services Administration
  Crystal Mall Building 4
  Washington, D.C. 20406
  (202) 557-1583

Readers should also refer to a three-part article entitled "Guaranteed-Maintenance Purchasing" in the June, July and August 1968 issues of American City.

Step 4: Establish Priorities Among the Evaluation Criteria

All evaluation criteria are not equally important. Technical criteria are frequently more important than managerial and business criteria in purchasing complex products such as digital image processing equipment or detailed aerial surveys. Managerial and business criteria, however, are frequently more important in hiring a consultant to do a land use or resource inventory. These differences are taken into account by assigning weights to the technical, managerial, business and cost criteria defined in Steps 2 and 3. Screening criteria are never weighted.

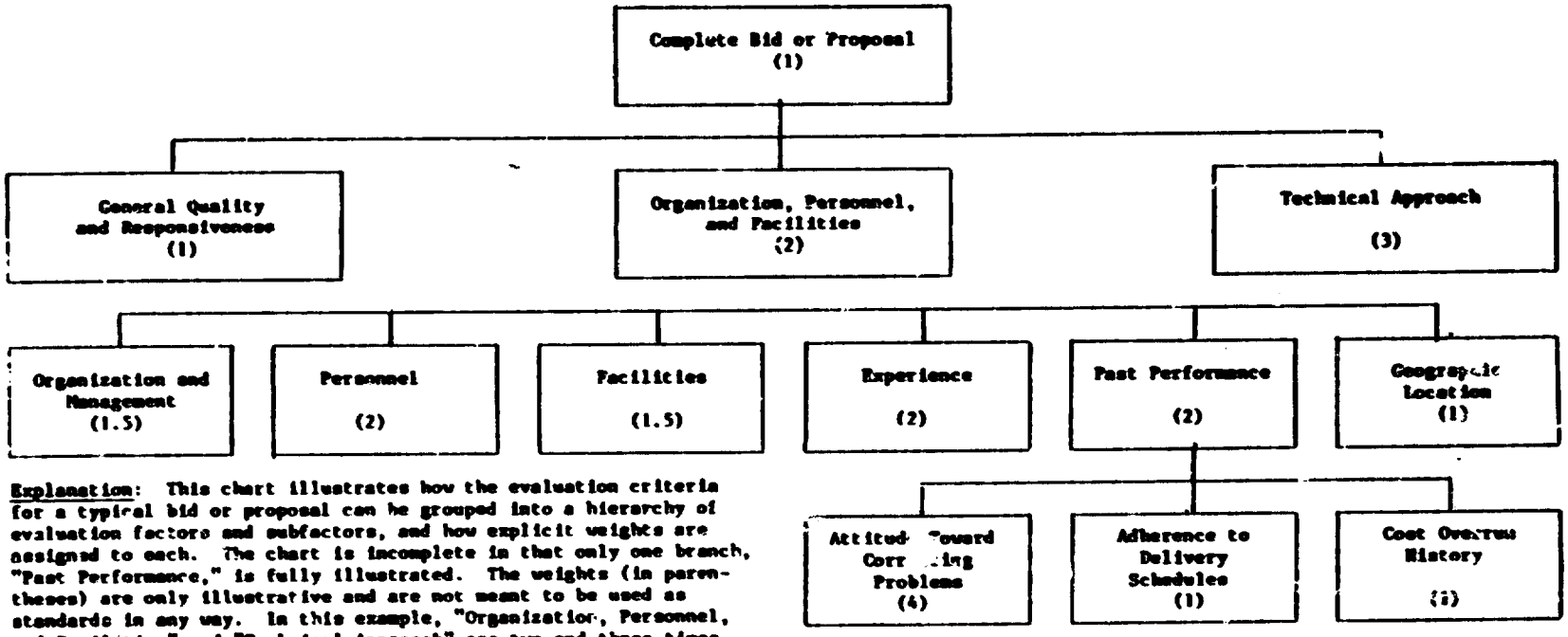
Evaluation criteria can be weighted in two ways, explicitly or implicitly. The explicit approach involves assigning numerical weights to each evaluation criterion -- each weight proportionate to the relative importance of the corresponding criterion. The criteria are weighted later by multiplying the value of each evaluation criterion by its corresponding weight. This is the recommended approach. The implicit approach involves assigning a maximum value to each evaluation criterion -- again, each maximum value being proportionate to the

relative importance of the corresponding criterion. This common approach is not recommended for two reasons. First, the relative importance of each evaluation criterion is less obvious to the observer with this approach. Second, because the maximum values vary, it is impossible to develop a scoring guide that can help the evaluators score each bid or proposals in a consistent fashion.

With the preceding discussion in mind, the procurement team should take the following actions:

- Divide the evaluation criteria into a hierarchy of factors and subfactors as illustrated in Figure II-3.
- Starting at the bottom of the hierarchy, assign a weight of "1" to the least important criterion in any one branch.
- Assign proportionate weights to the remaining criteria in that branch.
- Repeat the first and second actions listed above until explicit weights have been assigned to each evaluation criterion and factor in the hierarchy.

FIGURE II-3 -- A TYPICAL WEIGHT ASSIGNMENT SCHEME



Explanation: This chart illustrates how the evaluation criteria for a typical bid or proposal can be grouped into a hierarchy of evaluation factors and subfactors, and how explicit weights are assigned to each. The chart is incomplete in that only one branch, "Past Performance," is fully illustrated. The weights (in parentheses) are only illustrative and are not meant to be used as standards in any way. In this example, "Organization, Personnel, and Facilities" and "Technical Approach" are two and three times as important as "General Quality and Responsiveness," respectively; "Organization and Management" and "Facilities" are one and one-half times as important as "Geographic Location," while "Personnel," "Experience," and "Past Performance" are twice as important; and "Attitude Toward Correcting Problems" is four times as important as "Adherence to Delivery Schedules" and "Cost Overrun History."

MANAGEMENT APPROVAL POINT #3

State and local governments usually require a purchase requisition, approved by purchasing officer, before steps are taken to solicit bids or proposals. This approval signifies that the purchasing agency agrees that the need is justified, the requested product or service is feasible, and the necessary funds are available. Approval is usually perfunctory when the purchasing agency actively participates in the feasibility study and requirements development tasks. Otherwise, approval is dependent upon a thorough examination of the feasibility study, the technical and contractual specifications, and the evaluation criteria.

The procurement manager should submit the purchase requisition to the appropriate purchasing official as soon as the specifications and evaluation criteria have been developed. At a minimum, the requisition should include the following information:

- A brief nontechnical description of the requested product or service.
- The quantity of products or types of services being requested.
- A detailed technical description of the requested product or service, including the technical specifications developed in Task 4, all reporting requirements, and any serial numbers or other identifying codes.
- The evaluation criteria and corresponding weights developed in Task 6.
- The estimated acquisition cost, including any applicable unit prices.
- The funding source, identifying specific budgetary programs or line-items.

- A listing of prospective contractors or suppliers including a thorough justification of all suggestions for sole-source or limited source procurements.

- Copies of the Need Statement and Feasibility Report.

- Signatures from the requisitioner and appropriate purchasing officials.

SECTION III -- BID OR PROPOSALS SOLICITATION

This Section describes how to solicit bids or proposals from contractors or suppliers of remote servicing services and products. The objectives are:

- To establish a viable procurement strategy and develop the documents that are used to solicit qualified bids or proposals, and
- To encourage qualified contractors or suppliers to submit bids or proposals for the required work.

TASK 7: DEVELOP THE SOLICITATION DOCUMENT

The soliciation document must provide prospective contractors or suppliers with all the information they need to respond to the solicitation, including all technical and contractual requirements, evaluation criteria, and weights developed in Section II; the chosen procurement strategy; instructions for preparing and submitting the bids or proposals; and applicable procurement policies and procedures. The evaluation criteria, their weights, and the procurement strategy are especially important pieces of information because they allow the prospective contractor or supplier to structure his bid or proposal so that it stresses appropriate points and better reflects the jurisdiction's need.

The solicitation document -- variably termed an Invitation for Bids (IFB), Request for Bids (RFB), Request for Proposals (RFP), and Request for Technical Proposals (RTP) -- is developed in four steps:

1. Select a procurement strategy.

2. Develop instructions for preparing and submitting bids or proposals.

3. Develop procedures for handling inquiries and irregularities in the solicitation.

4. Assemble the solicitation document.

The entire procurement team should be involved in selecting the procurement strategy, but the procurement specialist should be given primary responsibility for performing the remaining three steps.

Step 1: Select a Procurement Strategy

There are three basic strategies that state and local governments can use in remote sensing procurements. These strategies are:

- Sealed Competitive Bidding,
- Design Competition, and
- Negotiation.

Each strategy has three or four variations. Sealed Competitive Bidding, sometimes called formal advertising, can be conducted in one or two steps and usually is open to all interested firms; a related strategy is limited to prequalified firms. Design Competition can also be conducted in one or two steps and either be open to all interested firms or limited to prequalified firms. Negotiations, meanwhile, can be conducted simultaneously with the offerors of priced technical proposals or unpriced conceptual proposals, sequentially with the offerors of unpriced conceptual proposals, or -- when necessary -- with only one potential contractor or supplier.

The procurement team should familiarize itself with these three basic strategies and their nine variations, and then select the one most appropriate for the current procurement. These procurement strategies are described in detail, below, and summarized in Table III-1. The following strategy selection guidelines should also be considered:

- IF detailed specifications can be prepared and sufficient competition exists to obviate technical discussions on specific proposals, THEN USE One-Step Competitive Bidding.
- IF detailed specifications can be prepared, time is available, and technical discussions pertaining to specific proposals are required to assure sufficient competition, THEN USE Two-Step Sealed Competitive Bidding.
- IF detailed technical concepts are the most important factors, time is not a limiting factor, cost is at most a limiting factor, and money is not available to compensate unsuccessful finalists, THEN USE One-Step Design Competition.
- IF detailed technical concepts are the most important factors, time is not a limiting factor, cost is at most a limiting factor, and money is available to compensate unsuccessful finalists, THEN USE Two-Step Design Competition.
- IF detailed technical concepts are the most important factors, cost is at most a limiting factor, money is available to compensate unsuccessful finalists, and either time is limited or qualifications are important, THEN USE Prequalified Design Competition.
- IF detailed technical concepts and cost are equally important, and the trade-offs between technical and cost factors cannot be made without detailed cost data, THEN USE Competitive Negotiations.
- IF detailed specifications cannot be prepared, cost and/or technical concepts are as important as qualifications, and several experienced negotiators are available, THEN USE Parallel Negotiations.
- IF detailed specifications cannot be prepared, cost is at most a limiting factor, and qualifications are the most important factor, THEN USE Sequential Negotiations.

TABLE III-1 -- PROCUREMENT STRATEGIES

CHARACTERISTICS:	Sealed Competitive Bidding		Design Competition			Negotiation			
	One-Step	Two-Step	One-Step	Two-Step	Prequalified	Competitive	Parallel	Sequential	Sole-Source
Initial bids or proposals can be modified prior to awarding a contract	NO	YES	NO	NO	NO	YES	YES	YES	YES
The qualifications of potential suppliers are evaluated before accepting technical proposals	NO	NO	NO	NO	YES	NO	YES	YES	YES
Price or cost is considered in evaluating the bids or proposals	YES	YES	NO	NO	NO	YES	YES	NO	NO
The technical approach is considered before starting negotiations	N/A	N/A	N/A	N/A	N/A	YES	NO	NO	NO
Compensation is paid to unsuccessful finalists	NO	NO	NO	YES	YES	NO	NO	NO	NO

- o If competition is lacking -- that is if there is only one contractor willing and capable of supplying the required product or service -- THEN AND ONLY THEN USE Sole-Source Negotiations.

A wide range of remote sensing systems or techniques have been included in this Guide. Consequently, the most appropriate procurement strategy will vary according to the complexity and innovative character of the anticipated procurement. As can be seen in the following discussion, Sealed Competitive Bidding may often be sufficient for routine aerial surveys where technical specifications can be clearly stated. However, more sophisticated or innovative techniques, such as those employing computer analysis of digital records, thermal infrared surveys, radar surveys, or very large projects involving coordination between several agencies, may be better obtained through procurement strategies such as Design Competition or Negotiation. These strategies require that the procurer have a clear and precise statement of the information need, but allow more opportunity for the offerors to bid a variety of remote sensing techniques to meet that need. With these latter two strategies, technical concepts can be addressed with more flexibility.

Sealed Competitive Bidding. The Sealed Competitive Bidding strategy awards the contract to the most suitable bid or "best buy" as defined by low cost and other stated evaluation criteria. It differs from the formal advertising strategy used by the Federal Government in two ways. First, the lowest cost bid may not win the contract even if it satisfies all minimum requirements and qualifications. Second, each bid should be separated into a technical and

managerial proposal, contractual conditions, and a bid price and submitted in three separate envelopes in order to eliminate pricing biases in the bid evaluation phase.

While purchasing officials recommend that this strategy be used in most procurement projects, it is limited in three ways. First, the Sealed Competitive Bidding strategy provides no opportunity for discussing and making trade-offs with individual bidders. Second, the strategy requires comprehensive, detailed technical specifications. Third, the strategy requires a sufficient number of qualified bidders to assure open price competition. Unfortunately, some remote sensing procurement projects are frequently characterizied by significant trade-offs, inadequate specifications, and an insufficient number of qualified bidders. Nevertheless, state and local governments should consider three variations of this basic strategy: One-Step Competitive Bidding, and Two-Step Competitive Bidding.

One-Step Competitive Bidding is the predominant procurement strategy used by state and local governments in purchasing standard products and services. The strategy involves one solicitation of priced bids from interested firms. It is preferred over the other Competitive Bidding strategies because it is quicker, simpler, and more objective. The absence of any formal mechanism for conducting pre-award discussions with individual bidders does, however, make it most appropriate for the more conventional remote sensing procurements such as aerial surveys where comprehensive detailed technical requirements are easier to develop. This strategy eliminates opportunities for the procurement team to improve its understanding of

each bid and the bidder to correct otherwise incomplete or marginal bids. This, in turn, emphasizes the importance of developing comprehensive, detailed technical requirements -- probably the most difficult task of a procurement project.

Two-Step Competitive Bidding, as its name indicates, involves two separate solicitations. The first solicitation is a formally advertised request for unpriced technical proposals. The procurement team evaluates these proposals and decides whether they are acceptable without modification, acceptable pending minor modifications, marginally acceptable, or clearly unacceptable. The team then talks with the offerors of the acceptable proposals to ensure that the proposals were correctly interpreted, to clear up ambiguities or confusing statements, and to correct minor errors or omissions. The second solicitation is an unadvertised request for priced bids from the offerors of previously acceptable technical proposals. While the previously noted technical discussions overcome one of the major deficiencies of the One-Step strategy, the Two-Step strategy is more complex and time consuming, and less equitable (due to the conversations with individual bidders). It also requires strong specifications. Also, bidders who are not invited to submit priced bids in the second solicitation may be able to halt or overturn the procurement in a court of law if the decision to reject their offers was not based on the objective application of stated evaluation criteria.

Design Competition. The Design Competition strategy awards the contract to the proposal with the best technical approach,

subject to its meeting stated requirements and a maximum cost target. The contract terms, conditions, and target cost are all set by the procurement team as part of the advertised contest rules. The strategy -- also called Design-to-Cost, Reverse Two-Step, and Design-Build -- differs from the Sealed Competitive Bidding and Negotiation strategies in that cost is established first and the competition focuses solely on performance or quality. This results in more creative, more innovative, higher quality proposals and eliminates the need to make difficult cost effectiveness trade-offs. The absence of cost competition may, however, be contrary to competitive bidding laws in some states. Design Competitions also are time consuming and expensive to evaluate, incur the added cost of compensating unsuccessful finalists or risk attracting fewer responses than other procurement strategies (due to the high cost of preparing detailed technical proposals), and may cause the jurisdiction to purchase more than it really needs or can use (if the target cost is set too high).

State and local governments should consider three variations of this basic strategy: One-Step Design Competition, Two-Step Design Competition, and Prequalified Design Competition. With the One-Step Design Competition strategy, detailed technical proposals are solicited from all interested contractors or suppliers, they are evaluated, and the best design is selected. With the Two-Step strategy, preliminary technical proposals are solicited from interested contractors or suppliers. These then are evaluated and the offerors of the best three to five proposals are asked to submit final, detailed proposals. With the Prequalified strategy, interested contractors

or suppliers are first asked to submit statements of qualifications. The procurement team then evaluates these statements and asks the two to five most qualified firms to submit detailed technical proposals. The contract is awarded to the best detailed proposal and unsuccessful finalists are paid an honorarium as compensation for their proposal efforts under both the Two-Step and Prequalified Design Competition strategies.

Each of these three Design Competition strategies has its relative advantages and disadvantages. The One-Step strategy is the simplest and least expensive, but the high cost of preparing detailed technical proposals coupled with the relatively small chance of any one contractor or supplier winning the competition combine to keep many smaller contractors or suppliers from competing -- even if cash prizes were awarded to the runner up in the competition. The Two-Step and Prequalified strategies are more complex, require that unsuccessful finalists be compensated for their proposal efforts, and attracts more competition. The Prequalified strategy offers one major advantage over the One-Step strategy -- it reduces the time and expense required to evaluate the technical proposals because there are fewer proposals to evaluate. The corresponding disadvantage is the potential loss of some creative, innovative, high quality proposals.

Negotiation. The Negotiation strategy involves substantive discussions about both price and technical approach with one or more contractors or suppliers. These discussions offer the procurement team an opportunity to gain added knowledge and insight into a

contractor's or supplier's understanding of the requirements and into the benefits and limitations of his technical approach -- information that is essential to making reasonable cost effectiveness trade-offs. Negotiation, however, is both an art and a skill. Inexperienced negotiators, no matter how familar they are with the procurement, are no match for skilled negotiators backed up by technical experts. The Negotiation strategy is also more susceptible to favoratism and political pressure than the Sealed Competitive Bidding and Design Competion strategies, and appears to be less equitable and credible. Furthermore, state procurement laws and regulations may place limits on the use of Negotiations. Nevertheless, state and local governments should consider the following four variations of this basic strategy: Competitive Negotiations, Parallel Negotiations, Sequential Negotiations, and Sole-Source Negotiations.

The Competitive Negotation strategy involves soliciting detailed technical and cost proposals, evaluating these proposals, and negotiating with the offerors of the best three or four proposals. The solicitation should require that the technical and managerial information, contractual conditions, and cost data be submitted in three separate envelopes to reduce pricing biases in the evaluation phase. The procurement team then evaluates each proposal using established evaluation criteria, and conducts negotiations with the offerors of the three or four proposals that are clearly superior to all others. Finally, the contract is awarded to the contractor or supplier offering the best overall deal to the jurisdiction. This strategy should

also allow the jurisdiction to award the contract without conducting negotiations if the evaluation shows one proposals to be acceptable and clearly superior to all others.

The Competitive Negotiation strategy combines many of the advantages of Sealed Competitive Bidding and Negotiation. The evaluation phase is as quick, simple, and objective as the One-Step Competitive Bidding strategy. The negotiation phase, meanwhile, provides opportunities for the procurement team to (1) improve its understanding of each proposal, and (2) discuss and make cost effectiveness tradeoffs with individual contractors or suppliers. As a result, there is more competition with this strategy than any other Negotiation strategy. Its primary disadvantage relative to other Negotiation strategies is the need for comprehensive, detailed technical requirements. It may also require sufficient numbers of skilled negotiators and technical personnel to man several negotiating teams. These characteristics make it well suited for purchasing complex remote sensing systems, especially those which involve acquiring automated analysis capabilities or nonstandard techniques.

The Parallel Negotiation strategy combines prequalification with simultaneous negotiations. Interested contractors or suppliers are asked to submit statements of qualification and, occasionally, brief conceptual proposals. The procurement team evaluates these submissions; selects the three or four most qualified firms; and solicits technical, managerial, and cost proposals from each. Direct negotiations are then conducted with each of these firms simultaneously, and the contract is awarded to the contractor or supplier

offering the best overall deal to the jurisdiction. The primary advantage offered by this Parallel Negotiation strategy in comparison with the Sequential and Sole-Source Negotiation strategies is increased competition. It may, however, require sufficient numbers of skilled negotiators and technical personnel to man several negotiating teams.

The Sequential Negotiation strategy is the traditional method that state and local governments use to hire architects and engineers and is not likely to be used for remote sensing procurements.

The Sole-Source Negotiation strategy, as its name indicates, involves negotiations with only one potential contractor. The Sole-Source Negotiation strategy should be used only as a last resort because it is the least competitive and the least advantageous to government.

Step 2: Develop Instructions for Preparing and Submitting Bids or Proposals

Interested contractors or suppliers obviously need clear and concise instructions on when, where, and how bids or proposals may be submitted, and whom to contact for further information. The procurement team must, therefore, decide upon:

- A closing or due date for submitting bids or proposals -- leave sufficient time for advertising the procurement and for contractors or suppliers to prepare their bids or proposals.
- A closing time.
- A location, including full mailing address, for receiving the bids or proposals.
- A label that identifies each bid or proposal as responding to a specific solicitation.

- A date, time, and location for opening the bids or proposals.
- The number of copies of each bid or proposal that must be submitted.
- The type and amount of any bid guarantees that must accompany a bid or proposal.
- Other information that must accompany each bid or proposal -- for example, the evaluation criteria may require submittal of a firm's latest corporate annual report or other evidence of financial stability, a list of previous clients for whom the bidder has done similar work, information on local representatives, or other pertinent samples of the bidder's work.
- The name, title, organization, mailing address, and phone number of the person to contact fur further information.
- A tenative contractor selection date, based upon the closing or due date and the time required to evaluate all the bids or proposals.

The procurement team must also describe how each bid or proposal must be organized. Otherwise, each bid or proposal will be organized differently, important information will be missing, and it will be extremely difficult to evaluate the bids or proposals. Thus, the procurement team must specify:

- The topics that each bid or proposals must address -- these topics must cover each evaluation criterion.
- The titles and sequence of these topics.
- A page and section numbering scheme.
- How proprietary or otherwise confidential information should be designated.
- How multiple bids or proposals must be prepared if they are acceptable.
- How to package and deliver samples or prototypes, if they are required, and their final disposition.
- How, when, and where interviews or oral presentations

will take place, if at all, and the topics they will cover.

Finally, the procurement team must develop any data forms, such as qualification form or cost-price disclosure form, that must be submitted with each bid or proposal. A Qualification Form is used for screening, prequalification, or sequential negotiation purposes. A Cost-Price Form is used to record the proposed cost or bid and for cost and price analysis.

Step 3: Develop Procedures for Handling Inquiries and Irregularities in the Solicitation

Some remote sensing procurements involving innovative techniques or sophisticated equipment, may be characterized by inquiries and irregularities. Contractors and suppliers will inevitably want to ask questions during their preparation of bids or proposals. These questions will occasionally uncover mistakes, omissions, or ambiguities in the solicitation document. Contractors or suppliers may also uncover errors in bids or proposals they have submitted. Other irreguiarities include late submittals and challenges to the specifications or contract award. The procurement team must develop procedures for handling each of these situations.

Before these procedures can be developed, the procurement team should designate one team member as the Buyer. The Buyer, usually a procurement specialist, should function as the focal point for all interaction between the government and interested contractors or suppliers. The Buyer must be thoroughly familiar with all the technical, managerial, and business aspects of the procurement, and be capable

of interpreting them to interested contractors or suppliers. The Buyer must also understand the relationships between this procurement and other programs or projects, and its effects on work schedules and costs. Finally, the Buyer must understand the acceptable trade-offs among delivery, cost, and quality constraints.

The Buyer should be guided by the following principles when establishing procedures for handling inquiries and amending the solicitation:

- The Buyer must be the focal point for all communication between the government and interested contractors or suppliers. Under no circumstances should technical or other personnel communicate with contractors or suppliers without the prior approval of the Buyer.

- All interested contractors or suppliers must be promptly notified by telephone or telegram of any material changes to the solicitation document, clarifications of significant ambiguities, corrections or mistakes or omissions, or other information that would provide one recipient with a competitive advantage.

- The Buyer should maintain a log of all communication with interested contractors or suppliers. This not only reinforces the need for equal discussion and disclosure, it also provides useful support in the event that any future disputes reach a court of law.

- A letter or telegram confirming each significant conversation with an interested contractor or supplier must be sent to all interested contractors or suppliers.

- No information should be disclosed by any person concerning the contents, status, or evaluation of any bids or proposals until after an award recommendation is made. If freedom of information laws make bids or proposals a matter of public record as soon as they have been opened, then reviews of such material should be allowed only under the full control and supervision of the Buyer. Proprietary information is never subject to review, and the complete bids or proposals should never be turned over to anyone for inspection.

The Buyer should be guided by the following principles when establishing procedures for handling modifications to bids or proposals, late bids or proposals, and challenges to the specifications or contract award:

- Modifications Before the Due Date -- Contractors or suppliers are generally allowed to correct mistakes or omissions, submit superceding bids or proposals, or withdraw their bids or proposals any time prior to the deadline for submitting responses.

- Corrections After the Due Date -- Corrections to a bid or proposal are generally allowed only if the jurisdiction knew, or had reasons to believe, that a mistake had been made. Where such corrections are not allowed, the bid or proposals can usually be withdrawn. Minor irregularities may usually be waived and minor clerical errors corrected if they are not contrary to the government's primary objective of selecting the most advantageous offer.

- Late Bids or Proposals -- These are generally unacceptable.

- Challenges to the Specifications or Contract Award -- Decisions of the procurement manager generally may be appealed to the chief administrative officer. However, appeals based on the reasonableness of the specifications should be limited to those that are initiated before the bid or proposal opening.

Step 4: Assemble the Solicitation Document

The Buyer should now assemble the various pieces of the solicitation document into one coherent document. This document should include six specific sections:

- Submission instructions, developed in Step 2.

- Proposal preparation instructions, also developed in Step 2.

- Applicable procurement policies and procedures, developed in Step 3.

- All product or service requirements, including the technical specifications developed in Task 4, the contractual

specifications developed in Task 5, and the evaluation criteria developed in Task 6.

- o Information and data forms, developed in Step 2.
- o A glossary of all the significant technical, managerial, and business terms used in the solicitation document.

In assembling the solicitation document, the Buyer should realize that it is better to incorporate the technical and contractual specifications and evaluation criteria into the solicitation document by referencing attachments than to incorporate these requirements directly.

The assembled bid or proposal solicitation document should be reviewed by the procurement manager before it is sent to top management. Figure III-1, a Solicitation Document Checklist, should be used in this review to ensure that the solicitation document is complete.

MANAGEMENT APPROVAL POINT #4

Top management should be given the opportunity to cancel the solicitation at this point. The appropriate decision-makers should ask themselves whether the remote sensing product or service being purchased is still needed. If the answer is "yes," then the procurement team should proceed with the solicitation; if it is "no," then the procurement project should be canceled and the procurement team disbanded.

TABLE III-1 -- SOLICITATION DOCUMENT CHECKLIST

Submission Instructions

YES	NO	
☐	☐	Date and Time (submission deadline)
☐	☐	Location and Address
☐	☐	Label Designation
☐	☐	Opening Date, Time, and Location
☐	☐	Copy Requirements (specifying the number of copies of each bid or proposal that must be submitted)
☐	☐	Bid Guarantees (including types and amounts)
☐	☐	Accompanying Information (e.g., latest corporate annual report, references, listing of local representatives, work samples)
☐	☐	Contact Person (specifying the name, title, organization, mailing address and phone number of whom to contact for further information)
☐	☐	Tentative Contractor Selection Date

Table III-1 (continued)

Proposal Preparation Instructions

YES	NO	
☐	☐	Formatting Instructions (specifying the topics to address, their titles, and their sequence, plus a page and section numbering scheme)
☐	☐	Confidentiality Instructions (specifying the means of designating proprietary or otherwise confidential information)
☐	☐	Multiple Proposal Instructions (specifying whether multiple bids or proposals are acceptable and, if they are, how they should be prepared)
☐	☐	Packaging and Delivery Instructions (specifying how samples and prototypes should be packaged and delivered, if they are required, and how they will be disposed)
☐	☐	Oral Presentation Provisions (specifying whether an oral presentation is required and, if it is, when it will take place and what it should cover)

Procurement Policies and Procedures

YES	NO	
☐	☐	Inquiries (procedures governing the handling of inquiries)
☐	☐	Solicitation Document Amendments (procedures governing amending the solicitation document)
☐	☐	Bid or Proposal Modifications (procedures governing modifying or correcting bids or proposals, before and after the due date)

Table III-1 (continued)

Procurement Policies and Procedures (continued)

YES	NO	
☐	☐	Late Submissions (procedures governing the acceptability of bids or proposals that are submitted after the submittal deadline)
☐	☐	Challenges (procedures for contesting the specifications or contract award)

Product or Service Requirements

YES	NO	
☐	☐	Technical Specifications (including technical requirements, quality standards, reliability standards, and a detailed project workplan)
☐	☐	Contractual Specifications (including contract type, terms, and conditions)
☐	☐	Project Schedule (including total time span, milestone events and dates, and the final delivery date)
☐	☐	Evaluation Criteria (including their weights or relative importance)

Information and Data Forms

YES	NO	
☐	☐	Qualifications Form (including all information needed to determine the relative qualifications of an interested firm)
☐	☐	Cost-Price Disclosure Form (including the proposed cost or bid, and all information needed to analyze the reasonableness of price bids and the associated costs)

Glossary

YES	NO	
☐	☐	Glossary (defining all significant technical and business terms)

TASK 8: SOLICIT BIDS OR PROPOSALS

Bids or proposals must be actively solicited in three steps. The procurement team should:

1. Advertise the procurement.
2. Solicit bids or proposals directly from qualified firms.
3. Where necessary, conduct a pre-bid conference.

The procurement team should also be ready to handle any inquiries or irregularities regarding this solicitation according to the policies and procedures developed in Task 7, Step 3.

Step 1: Advertise the Procurement

State and local government purchasing regulations generally require that purchasing opportunities be advertised in local newspapers or other local media. The procurement team should also consider placing advertisements in regional, state, and national publications (e.g., newspapers, trade publications, and/or professional magazines) whenever the pool of qualified local contractors or suppliers is few in number.

The advertisement itself should attract interest in the procurement by describing the required remote sensing product or service in general terms. The advertisement should also describe how to obtain the bid or proposal solicitation document, where responses should be sent, and when they must be received by. Finally, the advertisement should describe any bid deposit or performance bond requirements. The solicitation document should be sent to all contractors or suppliers expressing an interest in the procurement.

Step 2: Solicit Bids or Proposals Directly

The Buyer should also solicit bids or proposals directly from qualified contractors or suppliers. The procurement team should develop a profile of a qualified firm based upon the previously established evaluation criteria. This qualifications profile should cover manpower requirements by skill, experience, and capability; production facility and equipment requirements by type, size, number and location; and other factors such as prior experience, past performance, and financial standing. The Buyer should then develop a list of contractor or suppliers with the requisite qualifications. This list should not be limited by immediate knowledge, but derived from a thorough examination of:

- Suggestions made by the requesting agency and members of the procurement team, as found in the Purchase Requisition.
- Suggestions made by Federal, state, or local government, agencies with remote sensing expertise (see Table I-2 and Appendix).
- Remote sensing professional and trade publications.
- Corporate brochures.
- The Remote Sensing Industry Directory.

Step 3: Conduct a Pre-Bid Conference (Optional)

Pre-bid conferences allow the procurement team to brief interested contractors or suppliers in a face-to-face group meeting. These conferences provide a forum for answering written questions submitted in advance of the meeting. They also enable attendees to raise questions which were overlooked earlier or are triggered by some

other question or response. Conferences also provide all attendees with the same or a very similar interpretation of the requirements. Unfortunately, many prospective bidders will not attend a pre-bid conference because of the time and travel costs involved and natural skepticism about receiving any meaningful information. Because of this, all changes and interpretations discussed at a pre-bid conference should be compiled in a written addendum to the bid or proposal solicitation document and disseminated to all contractors or suppliers who received the original documents.

A pre-bid conference must be carefully prepared and executed. The conference should be scheduled several days after all prospective bidders have received the bid or proposal solicitation document to enable them to review its contents. The Buyer should handle all questions and refer those that he cannot answer to the appropriate member of the procurement team. When called upon, procurement team members should confine their responses to a technical interpretation of the written requirement.

SECTION IV -- BID OR PROPOSAL EVALUATION

The purpose of this evaluation phase is to develop a sound recommendation to either award the contract to a particular contractor or to initiate negotiations with particular contractors. In developing this recommendation, the evaluators must be guided solely by the evaluation criteria established earlier in Task 6 (Section II). The specific objectives of this phase are:

- To prepare the evaluators so that they can be as objective as possible,
- To review the bids or proposals and reject those that are clearly unacceptable, and
- To evaluate and rank the acceptable bids or proposals.

TASK 9: PREPARE THE EVALUATORS

Preparations for conducting the bid or proposal evaluation involve two steps:

1. Prepare the appropriate evaluation forms.
2. Select and brief the evaluators.

The procurement and requirements specialists should collaborate in designing the evaluation forms. The procurement manager is responsible for selecting and briefing the evaluators.

Step 1: Prepare the Appropriate Evaluation Forms

At least two evaluation forms are needed in every procurement effort -- a screening form and one or more detailed evaluation forms. The screening form is designed to identify bids or proposals that are clearly unacceptable or only marginally acceptable in a quick and simple manner so that the procurement team can concentrate its efforts on acceptable bids or proposals. The detailed evaluation forms are used to determine how acceptable each bid or proposals is relative to each other.

While no single evaluation form is appropriate in all situations, all should provide the same information. Every evaluation form should identify the product or service being purchased; identify the offeror of each bid or proposal (by letter or number, not by name); name the evaluator and note the date of the evaluation; list the evaluation factors, and criteria and appropriate weights; provide instructions for the evaluators. The specific design of each evaluation form does vary, however, depending upon its purpose. The following guidelines and illustrations are provided to help the procurement team select the most

appropriate design for each form.

- Screening forms should use either the Objective Checklist technique (Figure IV-1) or the Adjective Rating technique (Figure IV-2), as these are the simplest techniques capable of differentiating between acceptable and unacceptable responses.

- Detailed evaluation forms should generally use the Numerical Rating technique and/or the Ratio technique -- both provide the greatest possible degree of discrimination between competing bids or proposals, and both enable the evaluators to weight each evaluation criterion using the Weighted Factors Form (Figure IV-3).

- Consideration should also be given to using the Relative Ranking technique (Figure IV-6), instead of the Numerical Rating and Ratio Techniques, in the design of evaluation forms used to select the most capable and responsible of several acceptable firms; this usually occurs when the procurement strategy is prequalified design competition, parallel negotiation, or sequential negotiation. The Numerical Rating and Adjective Rating techniques can also be used for this purpose.

The Objective Checklist technique, illustrated in Figure IV-1, requires each evaluator to determine only whether a bid or proposal is acceptable or unacceptable with respect to each screening criterion. The criteria are not weighted. The simplest of all techniques, it should be used in nearly all circumstances.

The Adjective Rating technique, illustrated in Figure IV-2, requires each evaluator to assign one of three or more degrees of acceptability to each bid or proposal and screening criterion. For example, each evaluator might be required to determine if a bid or proposal "exceeds minimum requirements for particular criteria, meets minimum requirements, is unacceptable but correctable, or is totally unacceptable" or, alternatively, if the responses are "excellent, very good, average, poor, or unsatisfactory." The criteria are not weighted.

Project Title: Remote Sensing

Proposal ID: A

Evaluator Name: Carl Jones

Evaluation Date: 5/30/80

EVALUATION CRITERIA \ RESPONSE RATING	Acceptable	Unacceptable	Incomplete
1. General adequacy of technical proposal in meeting specified requirements such as "scale," "resolution," "products," ...			
2. Previous experience.			
3. Technical capability to perform stated objectives.			
4. Project management			
TOTALS:			

INSTRUCTIONS on reverse.

Figure IV-1. SAMPLE SCREENING FORM: OBJECTIVE CHECKLIST TECHNIQUE. This screening form is appropriate for nearly all circumstances.

INSTRUCTIONS:

1. Fill in the title of the procurement project.

2. Identify the proposal by letter or number.

3. Sign your name.

4. Fill in the date of the evaluation.

5. Review the acceptability of the proposal with respect to each evaluation criterion.

6. Mark the appropriate column for each evaluation criterion. Check the column marked "Incomplete" if you cannot determine the acceptability of the proposal.

7. Sum each column.

Figure IV-1 Continued

Project Title: Remote Sensing

Proposal ID: A

Evaluator Name: Carl James

Evaluation Date: 5/30/80

RESPONSE RATING / EVALUATION CRITERIA	SCORE:	Exceeds Requirements	Meets Requirements	Below Normal	Unacceptable	Incomplete	SCORE
		8	5	2	0	0	-
1. General adequacy of technical proposal in meeting specified requirements such as "scale," "resolution," "products," ...							
2. Previous experience.							
3. Technical capability to perform stated objectives.							
4. Project management.							
	TOTALS:						

INSTRUCTIONS on reverse.

Figure IV-2. SAMPLE SCREENING FORM: ADJECTIVE RATING TECHNIQUE. This form should be used to screen bids or proposals only when it is important to differentiate between superior and acceptable performance or quality. It could also serve as an evaluation form if the criteria are equally weighted.

INSTRUCTIONS:

1. Fill in the title of the procurement project.

2. Identify the proposal by letter or number.

3. Sign your name.

4. Fill in the date of the evaluation.

5. Review the acceptability of the proposal with respect to each evaluation criterion.

6. Mark the appropriate column for each evaluation criterion. Check the column marked "Incomplete" if you cannot determine the acceptability of the proposal.

7. Sum each column.

Figure IV-2 Continued

More complex than the Objective Checklist technique, the Adjective Rating technique should be used only when it is important to differentiate between superior and just acceptable performance or quality.

The Weight Factors Form, illustrated in Figure IV-3, requires each evaluator to assign a numerical value or score to each evaluation criterion using either the Numerical rating technique or the Ratio technique. (Both of these techniques are described below.) The scores, ranging from zero to 100, are then weighted -- multiplied by the corresponding weights established earlier in Task 6, Step 4. Finally, a total weighted score is calculated for each bid or proposal by summing and weighting these weighted scores, factor by factor and part by part.

The Numerical Rating technique requires the evaluators to use their judgment in assigning raw, unweighted scores. The procurement team should develop an Evaluator Scoring Guide, similar to the one illustrated in Figure IV-4, to help the evaluators score each bid or proposal in a consistent manner. This is accomplished by defining the range of numerical values or scores appropriate for various levels of acceptability The Scoring Guide should also be designed to create breakpoints or significant point spreads among bids or proposals in order to reduce the averaging effect caused by a low score on one factor or criterion and a high score on another. These breakpoints are created by assigning a score of zero to all unacceptable responses regardless of their degree or unacceptability.

Judgment is all but eliminated with the Ratio technique, where scores are calculated mathematically as follows:

FIGURE IV-3 -- SAMPLE WEIGHTED FACTORS EVALUATION FORM: PARTIALLY COMPLETE*

Project Title: Remote Sensing

Proposal ID: A

Evaluator Name: Carl Jones

Evaluation Date: 6/8/80

(INSTRUCTIONS on reverse)

Evaluation Criteria	Weights (1)	Weights (2)	Weights (3)	Raw Score (4)	Weighted Score (5)=(1)x(4)	Factor Score (6)= (5)/ (1)	Weighted Factor Score (7)=(2)x(6)	Part Score (8)= (7)/ (2)	Weighted Part Score (9)=(3)x(8)
Part I: General Quality and Responsiveness			.17						
A. Completeness and Thoroughness		.30							
B. Grasp of Problem		.55							
C. Responsiveness to Terms and Conditions		.15							
Part II: Organization, Personnel, and Facilities			.33						
A. Organization and Management Practice		.15							
B. Personnel Qualifications		.20							
C. Adequacy of Facilities		.15							
D. Experience in Related Fields		.20							
E. Record of Past Performance		.20							
1. Attitude Toward Correcting Problems	.40			85	34				
2. Adherence to Delivery Schedules	.40			85	38				
3. Cost Overrun History	.20			90	18				
F. Geographic Location		.10							
Part III: Technical Approach			.50						
A. Reliability		.20							
B. Manageability		.10							
C. Productivity and Economy		.10							
D. Technical Data and Documentation		.15							
E. Overall Size and Weight		.25							
F. Power Consumption		.20							
OVERALL RATING									

Figure IV-3 (continued)

INSTRUCTIONS

1. Fill in the title of the procurement project.
2. Identify the proposal by letter or number.
3. Sign your name.
4. Fill in the date of the evaluation.
5. Record the weights assigned to each evaluation criterion in Column 1, the weights assigned to each evaluation factor (group of evaluation criteria) in Column 2, and the weights assigned to each part of the proposal (group of evaluation factors) in Column 3.
6. Review the acceptability of the proposal with respect to each evaluation criterion, using either an Evaluator Scoring Guide (Figure IV-4 or the Ratio technique (Figure IV-5) for guidance in assigning a score to each evaluation criterion.
7. Record the Raw Scores assigned to each evaluation criterion in Column 4.
8. Calculate the Weighted Score of each evaluation criterion by multiplying the Raw Score (Column 4) by its corresponding weight (Column 1), and record the products in Column 5.
9. Calculate each Factor Score by summing the Weighted Scores of component evaluation criteria (Column 5) and dividing the total by the sum of the corresponding weights (Column 1). Record the results in Column 6.
10. Calculate the Weighted Factor Scores by multiplying the Factor Scores (Column 6) by the corresponding weights (Column 2), and record the products in Column 7.
11. Calculate each Part Score by summing the Weighted Factor Scores of component factors (Column 7) and dividing the total by the sum of the corresponding weights (Column 2). Record the results in Column 8.
12. Calculate the Weighted Part Scores by multiplying the Part Scores (Column 8) by the corresponding weights (Column 3), and record the products in Column 9.
13. Calculate an Overall Rating by summing the Weighted Part Scores (Column 9).

*This illustration shows a partially completed evaluation of Proposal A. focusing on the offeror's record of past performance (Part II-3). Completion of columns 5-9 is illustrated in Figure IV-7. Note that in a real procurement this form would have to be expanded to provide room for scoring the component evaluation criteria of each evaluation factor.

FIGURE IV-4 -- SAMPLE EVALUATOR SCORING GUIDE

Numerical Score	Explanation		
100 points	Outstanding	--	The ideal response in all respects.
90-99 points	Excellent	--	Ideal in some, but not all, respects.
80-89 points	Very Good	--	Clearly exceeds minimum requirements.
70-79 points	Good	--	Contains a definable detail in excess of minimum requirements.
60-69 points	Adequate	--	Just meets minimum requirements.
50-59 points	Weak	--	Vaguely implies that capability is present, lacks clarity.
40-49 points	Poor	-	Minor misunderstanding of requirements, omission of minor details.
0 points	Unacceptable	--	Major misunderstanding of requirements, omission of major details, failure to respond.
0 points	Incomplete	--	

- If the response of a particular bid or proposal to a particular evaluation criterion (i.e., the Actual Response) is acceptable, and large values are better than small values, then:

$$\text{Score} = \frac{\text{(Actual Response)} \times 100}{\text{Best Response}}$$

- If the Actual Response is acceptable, and small values are better than large values, then:

$$\text{Score} = \frac{\text{(Best Response)} \times 100}{\text{Actual Response}}$$

- If the Actual Response is unacceptable, then:

$$\text{Score} = 0$$

Where the Best Response is the best value of any bid or proposal with respect to that particular evaluation criterion.

Thus, no Scoring Guide is needed and there is no opportunity for inconsistent or biased scoring. In place of a Scoring Guide, the procurement team should design and use a scoring sheet similar to the one illustrated in Figure IV-5. Unfortunately, the Ratio technique is limited to quantifiable factors by its very nature. It also suffers from the fact that unlike the numerical Rating technique, these scores are partially based upon the values of other bids or proposals.

The Relative Ranking technique, illustrated in Figure IV-6, requires each evaluator to develop a separate ranking of the bids or proposals for each evaluation criterion. Each ranking is scored as follows:

- The top-ranked bid or proposal is assigned a value greater than or equal to the total number of bids or proposals.
- Each succeeding lower-ranked bid or proposal is assigned a value one less than the previously ranked bid or proposal.

Project Title: Remote Sensing

Evaluator Name: Carl Jones

Evaluation Date: 6/8/80

Evaluation Criteria	L/S* (1)	Best Value (2)	Proposal A		Proposal B		Proposal C		Proposal D	
			Actual Value (3)	Score* (4)	Actual Value (5)	Score* (6)	Actual Value (7)	Score* (8)	Actual Value (9)	Score* (10)
Cost ($)	S	80,000	80,000	100	110,000	73	90,000	89	93,000	86
Emergency Distress Signal Range (miles)	L	7.5	6.0	80	7.5	100	7.0	93	6.3	84

*KEY: L = A large value is desired; Score = Actual Value/Best Value x 100.

S = A small value is desired; Score = Best Value/Actual Value x 100.

INSTRUCTIONS: On reverse.

Figure IV-5 -- SAMPLE SCORING FORM: RATIO TECHNIQUE. This illustration shows only a portion of a complete evaluation, specifically that portion dealing with two quantifiable criteria. The scores are unweighted and should be transferred to the Weighted Factors Form (Figure IV-3). There they are weighted and combined with scores for other evaluation criteria that were derived using the numerical rating technique.

FIGURE IV-5 (cont.)

INSTRUCTIONS:

1. Fill in the title of the procurement project.

2. Sign your name.

3. Fill in the date of the evaluation.

4. Identify the proposals by letter or number.

5. Record an "S" in Column 1 whenever small values of the evaluation criterion are favored over large values; record an "L" there whenever large values are favored over small values. Repeat for each evaluation criterion.

6. Review all the proposals and record the Best Value, with respect to each evaluation criterion, in the appropriate columns (Columns 3, 5, 7 and 9).

7. Record the Actual Value of each proposal, with respect to each evaluation criterion, in the appropriate columns (Columns 3, 5, 7 and 9).

8. Calculate the scores of each proposal on each evaluation criterion using the following scoring guide:

   - If small values are favored (i.e., Column 1 = "S"), then the Score is calculated by dividing the Best Value by the Actual Value and multiplying the result by 100.

   - If large values are favored (i.e., Column 1 = "L") then the Score is calculated by dividing the Actual Value by the Best Value and multiplying the result by 100.

   Record the results in the appropriate columns (Columns 4, 6, 8, and 10).

9. Transfer the Scores to Column 4 of the appropriate Weighted Factors Evaluation Forms.

Project Title: Remote Sensing

Evaluator Name: Carl Jones

Evaluation Date: 6/4/80

Scoring Guide:

Rank	1	2	3	4	5
Score	5	4	3	2	1

Evaluation Criteria	Proposal A		Proposal B		Proposal C		Proposal D		Proposal __	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Experience with similar (functional) work	1	5	2	4	4	2	3	3		
Experience with projects of the same size or cost	1	5	2	4	3	3	4	2		
Experience with government work	3	3	4	2	1	5	2	4		
Qualified personnel with the appropriate background and experience assigned to each task	4	2	1	5	1	5	3	3		
Ability to communicate	1	5	3	3	2	4	4	2		
Confidence and interest in the work	1	5	3	3	2	4	4	2		
Demonstrated management ability	1	5	2	4	4	2	3	3		
Adherence to delivery schedules	2	4	1	5	2	4	4	2		
Cost overrun history	3	3	2	4	1	5	4	2		
Attitude toward correcting problems	3	3	4	2	2	4	1	5		
Self-reliance	1	5	2	4	3	3	4	2		
End quality of the work	2	4	1	5	3	3	4	2		
Reputation of the firm	2	4	1	5	3	3	4	2		
Organizational condition of the firm	1	5	2	4	4	2	3	3		
Financial condition of the firm	4	2	2	4	3	3	3	3		
Affirmative action experience	1	5	2	4	3	3	4	2		
TOTAL	XXXX	65	XXXX	62	XXXX	55	XXXX	42	XXXX	

INSTRUCTIONS: On reverse.

FIGURE IV-6 -- SAMPLE SCORING FORM: RELATIVE RANKING TECHNIQUE. This illustration shows how bids or proposals can be ranked according to the relative capability and responsibility of each offeror. Note that the scores do not indicate how superior one bid is relative to another on each criterion; thus, the scores cannot be weighted and are not compatible with the scores derived from the Numerical Rating or Ratio techniques. Nevertheless, the illustration clearly ranks Proposal A highest, followed by Proposals B, C, and D in that order (assuming that each evaluation criterion is of equal importance).

FIGURE IV-6 Continued

INSTRUCTIONS:

1. Fill in the title of the procurement project.
2. Sign your name.
3. Fill in the date of the evaluation.
4. Identify the proposals by letter or number.
5. Review and rank each of the proposals on the basis of how well they satisfy the first evaluation criterion. Record the ranks in the appropriately headed columns.
6. Referring to the Scoring Guide, record the apprcpriate score for each rank in the appropriately headed columns.
7. Repeat Steps 5 and 6 for each evaluation criterion.
8. Sum the scores for each proposal.

- o If two or more bids or proposals are judged to be equal with respect to a particular criterion, they are assigned the same rank and score. Thus, Proposals A and C in Figure IV-6 are tied for second best with respect to "adherence to delivery schedules" and both receive a score of 4; the next best proposal, Proposal D, is assigned a score of 2.

- c All unacceptable responses are assigned a score of zero.

The scores are then summed, with the totals used to rank the bids or proposals. Note, these scores do not reflect how close one bid or proposal is to another (i.e., the scores use ordinal, not cardinal numbers); thus, they cannot be weighted and are not compatible with the scores derived from the Numerical Rating or Ratio techniques. This technique is most useful as a means of identifying the most capable and responsible of several acceptable contractors.

Step 2: Select and Brief the Evaluators

The procurement manager can now select the evaluators. In doing so, he should be guided by the following three principles. First, the evaluators should be objective, pragmatic, discriminating individuals who understand the technical and contractual requirements and evaluation criteria well enough to discern differences among the competing bids or proposals. Thus, technical personnel should evaluate technical factors, financial personnel should evaluate financial factors, and so on. Second, two or three persons should independently evaluate the responsiveness of each bid or proposal to each evaluation criterion. This minimizes the possibility that one evaluator's error or misunderstanding will affect the overall screening or evaluation decision. Third, anyone who evaluates the responsiveness of one bid or proposal to a particular evaluation criterion should do the same for every other bid or proposal.

Once selected, the evaluators should be given a detailed briefing on the procurement project covering such topics as:

- The Needs Statement.
- The Requirements.
- The Evaluation Criteria.
- The Evaluation Forms.
- The Evaluators' Responsibilities to be objective and consistent as possible.
- The Evaluators' Assignments -- who evaluates which evaluation factors?

TASK 10: SCREEN THE BIDS OR PROPOSALS

The procurement team should review all bids or proposals and identify those that merit further, more detailed consideration. This screening process allows the evaluators to concentrate their efforts on the more acceptable bids or proposals, and may allow interested contractors to delay their preparation of detailed technical proposals until their qualifications and/or conceptual proposals are judged acceptable. There are four steps to this process:

1. Open the bids or proposals.
2. Identify clearly unacceptable bids or proposals.
3. Rank the bids or proposals, as necessary.
4. Solicit additional information, as necessary.

Step 1: Open the Bids or Proposals

The Buyer should open all bids or proposals at the same time and place. The names of the offering firms should then be read aloud and written out for all to see. Price envelopes should not be opened and prices should not be revealed uness required by law. This suggestion is made because evaluators may subconsciously favor the low bid.

Once the bids or proposals have been opened, the names of the offering firms should be replaced by letter or number codes on all copies to be used by the evaluators. These letter or number codes should be assigned by someone who will not actively screen or evaluate the bids or proposals. This procedures will further reduce the amount of evaluator bias -- for or against particular firms -- that can enter into his evaluation.

Step 2: Identify Unacceptable Bids or Proposals

The evaluators can now screen out the unacceptable bids or proposals. They should start by reviewing the screening criteria listed on the Screening Form (developed in Task 9, Step 1). Next, they should read all the bids or proposals. Finally, they should review and rate each bid or proposal, recording the ratings on the Screening Form. Two completed Screening Forms are illustrated in Figures IV-1 and IV-2.

The procurement manager and the evaluators should review this initial evaluation together, determine the overall acceptability of each bid or proposal, and eliminate unacceptable bids or proposals from further consideration. They should consider only the essential requirements listed on the Screening Form in making this decision; important but nonessential features or qualifications should not be considered. Four categories of acceptability are possible:

- o Clearly acceptable -- without any qualifications.
- o Acceptable -- pending minor modifications to clear up ambiguities or confusing statements, or to correct minor errors or omissions.
- o Marginal -- the bid or proposal is generally responsive but there are some specific statements or conditions that, while unacceptable, are correctable.
- o Clearly Unacceptable -- the bid or proposal fails to address the stated requirements and contains major errors or omissions, or the offeror lacks the necessary qualifications.

The procurement team must now notify the offerors of clearly unacceptable bids or proposals that their offers have been eliminated from further consideration. The notification letter should briefly

state the reasons for rejecting the bid or proposal and offer a more detailed debriefing at a mutually acceptable time. The letter must be accompanied by any bonds posted with the bid or proposal. A similar letter should also be sent to the offerors of marginal bids or proposals if the procurement strategy is One-Step Sealed Competitive Bidding, One-Step Design Competition, or Prequalified Design Competition; and to the offerors of acceptable bids if the procurement strategy is One-Step Sealed Competitive Bidding and there are sufficient number of clearly acceptable bids to assure competition.

Step 3: Rank the Bids or Proposals, As Necessary

Depending upon the procurement strategy, it may be necessary to rank the bids or proposals in order to identify those that deserve further consideration. As Table IV-1 indicates, this becomes necessary whenever the procurement strategy is Prequalified Design Competition, Parallel Negotiations, Sequential Negotiation, or Two-Step Design Competition. In all but the last case, the rankings are based upon the relative qualifications of the interested contractors; rankings in Two-Step Design Competitions are based upon design factors. Skip directly to Step 4 if the procurement strategy is Two-Step Sealed Competitive Bidding; to Task 11 if it is One-Step Sealed Competitive Bidding, One-Step Design Competition, Competitive Negotiations, or Sole-Source Negotiations.

The ranking must be based upon criteria specified in the solicitation document. These criteria typically are some subset of the evaluation criteria that will be used to make a final award decision. The

TABLE IV-1 -- SCREENING CHECKLIST

Procurement Strategy	First Solicitation: Qualifications	First Solicitation: Technical Bid or Proposal	First Solicitation: Price Bid or Proposal	Further Consideration: Clearly Acceptable	Further Consideration: Acceptable	Further Consideration: Marginal	Further Consideration: Unacceptable	Ranking Basis	Discussions	Second Solicitation: None	Second Solicitation: Technical Bid or Proposal	Second Solicitation: Price Bid or Proposal
1-Step Sealed Competitive Bidding	Y	Y	Y	Y	Y^1	Y^2			T	Y	Y	Y
2-Step Sealed Competitive Bidding	Y	Y		Y	Y							
1-Step Design Competition	Y	Y	Y	Y	Y					Y		
2-Step Design Competition	Y	Y		*	*	*		D			Y	Y
Prequalified Design Competition	Y			*	*			Q			Y	Y
Competitive Negotiation	Y	Y	Y	Y	Y	Y^2				Y		
Parallel Negotiation	Y			*	*	*		Q		Y		
Sequential Negotiation	Y			*	*	*		Q	X	Y		
Sole Source Negotiation	Y	Y		N/A	N/A	N/A	N/A			Y		

NOTES: Y = Yes; D = Design Factors; Q = Qualifications; T = Technical; X = Exploratory; N/A = Not Applicable;

Y^1 = Yes, unless there are a sufficient number of clearly acceptable bids to ensure competition;

Y^2 = Yes, if there are an insufficient number of clearly acceptable and acceptable proposals to ensure competition.

evaluators should use either the Numerical Rating technique (Weighted Factors Form, Figure IV-3), the Relative Ranking technique (Figure IV-6), or the Adjective Rating technique (Figure IV-2), to develop the ranking conformance with plans developed in Task 9, Step 1.

The evaluators should skip to Task 11, Step 4, after completing this ranking if the procurement strategy is Parallel Negotiations.

Step 4: Solicit Additional Information, As Necessary

The procurement strategy may also require that additional information be solicited prior to the evaluation task. This solicitation can be a request for priced bids or a request for detailed technical proposals. It also can involve technical discussions with the offerors of acceptable proposals (prior to soliciting priced bids) or exploratory discussions with the most qualified contractors (with no actual solicitation taking place). Table IV-1 summarizes the effect of the procurement strategy on the need for additional information.

Technical discussions with the offerors of acceptable proposals are necessary only if the procurement strategy is Two-Step Sealed Competitive Bidding. Discussions should be held with the offerors of clearly acceptable proposals to ensure that their proposals were correctly interpreted. Discussions should be held with the offerors of acceptable proposals to clear up ambiguities or confusing statements, to correct minor errors, and to fill in minor omissions. Discussions should be held with the offerors of marginal proposals to determine whether their proposals can be modified and made acceptable only if there are an insufficient number of clearly acceptable and acceptable proposals to ensure competition.

Exploratory discussions must be held with at least the three most qualified contractors if the procurement strategy is sequential negotiations. These discussions should focus on their qualifications, their understanding of the work requirement, and their proposed managerial and conceptual approach. Two or more evaluators should participate in these discussions, and they should prepare a standard set of questions (based upon the evaluation criteria) to ask each contractor. The procurement team should skip directly to Task 11 for guidance on how to evaluate these top contractors or suppliers and select the top one for negotiations.

With the unacceptable bids or proposals identified and the rankings of the acceptable bids or proposals completed, the procurement team should:

- Assemble a new bid or proposal solicitation document requesting (a) priced bids if the procurement strategy is Two-Step Sealed Competitive Bidding, or (b) detailed technical proposals if it is Two-Step or Prequalified Design Competition (Task 7, Step 4).

- Send the solicitation document to all offerors of acceptable proposals if the procurement strategy is Two-Step Sealed Competitive Bidding, or to the offerors of the top three to five technical proposals if the strategy is Two-Step or Prequalified Design Competition (Task 8, Step 2).

- Remind these contractors that cash prizes or honorariums will be awarded to those that do not win the contract if the procurement strategy is Two-Step Design Competition, or Prequalified Design Competition.

- Notify the remaining contractors that they have been eliminated from further consideration. Again, the notification letter should briefly state the reasons for the rejection, offer a more detailed debriefing at a mutually acceptable time, and convey any bonds posted with the bid or proposal.

TASK 11: EVALUATE THE BIDS OR PROPOSALS

The evaluators should now have all the information they need to evaluate those bids or proposals that deserve further consideration. They must:

1. Evaluate the technical, managerial, and business factors specified in the solicitations document.
2. Analyze prices and costs.
3. Rank the bids or proposals.
4. Prepare an Evaluation Report that recommends awarding the contract to a particular contractor or initiating negotiations with particular contractors.

Step 1: Evaluate Technical, Managerial, and Business Factors

The evaluation effort begins with the evaluators addressing such concerns as:

- How well does the offeror understand the work requirements?
- How responsive is the bid or proposal to the solicitation in terms of both essential and nonessential but desired features or characteristics?
- How appropriate is the bid or proposal's overall technical approach of methodology?
- How adequate is the offeror's proposed management plan?
- How adequate is the offeror's proposed work plan?
- What is the likelihood that the offeror will be able to perform the work within the stated constraints?
- How reputable is the offeror?
- How well has the offeror performed on previous projects of a similar nature?
- How stable is the offering firm from both financial and managerial perspectives?
- How compatible are the offeror and the user or client's styles and philisophies?

- How well does the bid or proposal comply with applicable procurement policies and objectives?

The evaluators can draw upon several sources of information to answer these questions. Written bids or proposals are the primary source of information. Technical or exploratory discussions with individual bidders or offerors (Task 10, Step 4) are another major source. Other supplementary sources include procurement records maintained by the user or procurement agencies, references obtained from previous buyers or clients, credit and financial ratings or audit reports, and site visits conducted during the evaluation phase.

The evaluators should gather all the material needed to evaluate each bid or proposal; open the bids or proposals; code everything to eliminate references to the names of particular firms (as in Task 10, Step 1); and then evaluate each offer from a technical, managerial, and business perspective. The evaluators should proceed with the actual evaluation as follows:

- Review the bids or proposals and related information.
- Quickly identify unacceptable bids or proposals using the screening criteria and the Screening Form designed in Task 10, Step 1 (Figure IV-1 or IV-2).
- Review the detailed evaluations criteria specified in the solicitation document.
- Rate the acceptability of each acceptable bid or proposal (identified in the second item listed above) with respect to each evaluation criterion listed on the Weighted Factors Form (Repeated as Figure IV-7).
- Record each rating or "Raw Criterion Score" in column 4 of the Weighted Factors Form.

NOTE: The evaluation plans developed in Task 9, Step 1, may call for the use of the Relative Ranking technique (Figure IV-6), in place of the Weighted Factors Form in the fourth and fifth points above, if the procurement strategy is Sequential Negotiations.

Step 2: Analyze Prices and Costs

Price is probably the least subjective of all the evaluation criteria. Nevertheless, the evaluators should carefully examine the prices submitted on formal bids or proposals to determine if they are fair and reasonable.

Price analysis involves comparing a bid or proposal price to a "reference price" derived from: (1) the prices offered by competitors, (2) the prices paid by other buyers of a similar product or service, and/or (3) engineering estimates of what the product or service should cost. Open competition, as evidenced by three or more actual bids, is generally the most reliable method of determining a current, reasonable reference price. The prices paid by other buyers must be adjusted to account for varying circumstances and needs before they can be used as reference prices. Engineering estimates must be prepared by an independent third party in order to qualify as reference prices.

Price analysis can allow the evaluators to combine the price factor with the other technical, managerial, and business factors listed on the Weighted Factors Form. To do this, the evaluators must first translate each bid or proposal price into a price rating -- equivalent to the ratings developed for the other evaluation factors in Step 1 -- and record it next to the cost of criterion under column 4 on the Weighted Factors Form. This price rating is calculated as follows:

- If the offer price is greater than or equal to the reference price, divide the reference price by the offer price and multiply the dividend by 100.

- If the offer prices is less than the reference price, either of two approaches are feasible:

  (1) Divide the reference price by the offer price and multiply by 100.

  This approach is conceptually simple, but it suffers from two disadvantages. First, the rating is always greater than 100 and thus not comparable to the ratings for all other factors (other ratings are between zeros and 100). In effect, this overemphasizes the cost factor at the expense of all other factors. Second, this approach rewards instead of penalizes unrealisitically low bids or offers.

  (2) Divide the offer price by the reference price; multiply the dividend by 100; add a "margin for error" (e.g., 5, 10, 15, ...x); and, if the result is greater than 100, reduce it to 100.

  This approach is both comparable to the ratings developed for other evaluation factors and fair in that it penalizes unrealistically low bids or offers. Its problems stem from the method of penalizing low bids or offers. First, it assumes a margin of error of X% in setting the reference price and penalizes all bids or offers below this arbitrary level, regardless of whether or not the bid or offer is reasonable in light of the entire bid or proposal. Second, this approach equates all bids or proposals with prices between this arbitrary level and the reference price, giving all a rating of 100.

Penalties for unrealisitically low prices are important because low prices may signify a bidder or offeror's lack of understanding of the work requirements, or they may indicate incompetent estimating, sharp bidding practices, and likely cost overruns. The challenge is to develop a method that does not penalize the contractor or supplier for errors the procurement team may make in setting the reference price.

Cost analysis is another procedure for determining the fairness and reasonableness of a price; however, it should be used only when price analysis based on competitive bids or catalog prices is not

possible. Cost analysis is used in the following instances: (1) to analyze proposed prices or cost estimates in negotiated procurements, (2) to validate bills submitted under cost-reimbursement contracts, (3) to price changes to a contract, and (4) to determine the amount of any settlement when a contract is terminated. These last three instances occur during the contract administration phase, as discussed in Section VII.

Cost analysis involves breaking a price down into its component elements to determine whether each cost element is reasonable and allocable. Costs are considered reasonable if a prudent person would spend the same amount in a competitive business situation. Costs are considered allocable if they can be assigned to one or more organizational subdivisions, contracts, functions, or other work units in proportion to the relative benefits generated by those costs. For additional guidance on cost analysis, refer to the American Bar Association's Model Procurement Code for State and Local Governments, Article 7. Copies of this Model Procurement Code may be obtained by contacting:

- Coordinating Committee on a Model Procurement Code
  1800 M Street, N.W.
  Washington, D.C. 20036
  (202) 331-0133

When applying cost analysis, the evaluators should break a price down into four major categories: Direct Labor, Indirect Labor, Expenses, and G&A and Profit. Direct Labor costs are usually allocated to different labor categories by multiplying the number of person-hours, days, weeks, or months of work required in each labor category by the appropriate

pay rates. Fringe benefits and overhead charges, the two Indirect Labor costs, are usually allocated as a percentage of Total Direct Labor costs. Travel and per diem, consultants, subcontractors, direct materials, special equipment, and other specific expenses are usually allocated independently with as much justification as possible. G&A (i.e., General and Administrative) costs are usually allocated as a percentage of Direct and Indirect Labor, and Expenses, while profits or fees are usually allocated as a percentage of all other costs. The evaluators should evaluate the reasonableness of each of these costs, concentrating their efforts on the high cost areas of a proposal, on those areas where serious doubts to validity exist, and on the direct costs in general.

The procurement team should require the winning contractor to certify that the information contained on the Cost-Price Dislocure Form is complete, current, and accurate. Although the jurisdiction's legal counsel should be consulted on the actual wording of the certification statement, it might read "I hereby certify that, to the best of my knowledge and belief, all data herewith submitted are complete, accurate, and current."* An audit of the winning contractor's books and records may also be necessary to check these claims. This audit could be conducted by the government's own internal auditors or by an indepen-

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*Truth in Negotiations Act, U.S. Code, Vol. 10, Secs. 2306 F (1970). The Federal Government requires this certification in order to enable it to recoup, from the contractor, every dollar paid that is in excess of the true costs if a post-contract audit uncovers misrepresentations of costs or prices. The Federal Government requires that the certificate be executed after a price agreement has been reached as cost and pricing data are likely to be changed by the negotiation process.

dent accounting firm.

Step 3: Rank the Bids or Proposals

The next step is to rank all the acceptable bids or proposals in the order of their overall value to the jurisdiction. This is accomplished by using the Weighted Factors Form (repeated as Figure IV-7) to calculate Factor Scores, Part Scores and a Total Weighted Score for each bid or proposal as follows:

- Factor Score = ((Raw Score$_1$ x Criterion Weight$_1$) + (Raw Score$_2$ x Criterion Score$_2$) = (Raw Score$_3$ x Criterion Score$_3$) + ...) ÷ (Criterion Weight$_1$ + Criterion Weight$_2$ + Criterion Weight$_3$ + ...)

- Part Score = ((Factor Score$_1$ x. Factor Weight$_1$) + (Factor Score$_2$ x Factor Weight$_2$) + (Factor Score$_3$ x Factor Score$_3$) + ...)) ÷ (Factor Weight$_1$ + Factor Weight$_2$ + Factor Weight$_3$ + ...)

- Total Score = ((Part Score$_1$ x Part Weight$_1$) + (Part Score$_2$ x Part Weight$_2$) + (Part Score$_3$ x Part Weight$_3$) + ...) ÷ (Part Weight$_1$ + Part Weight$_2$ + Part Weight$_3$ + ...)

The total scores are then used to rank the bids or proposals. If the cost factor was not incorporated into the Weight Factors Form, and price or cost data are available, then the ranking should be adjusted at this time to account for price cost differences.

The rankings developed by individual evaluators frequently differ. Thus, after each evaluator ranks the bids or proposals, a composite ranking should be prepared. This composite ranking can be developed by averaging the total weighted scores for each bid or proposal and then comparing these averages, or by preparing a scatter chart to compare the actual rankings of individual evaluators. A scatter chart (illustrated in Figure IV-8) is a tabulation of the

Project Title: Remote Sensing

Proposal ID: A

Evaluator Name: Carl Jones

Evaluation Date: 6/8/80

(INSTRUCTIONS on reverse)

Evaluation Criteria	Weights (1)	Weights (2)	Weights (3)	Raw Score (4)	Weighted Score (5)=(1)x(4)	Factor Score (6)= (5)/ (1)	Weighted Factor Score (7)=(2)x(6)	Part Score (8)= (7)/ (2)	Weighted Part Score (9)=(3)x(8)
Part I: General Quality and Responsiveness			.17					79.95	13.6
A. Completeness and Thoroughness		.30				80	24.00		
B. Grasp of Problem		.55				75	41.25		
C. Responsiveness to Terms and Conditions		.15				98	14.70		
Part II: Organization, Personnel, and Facilities			.33					88.55	29.4
A. Organization and Management Practice		.15				65	9.75		
B. Personnel Qualifications		.20				40	18.00		
C. Adequacy of Facilities		.15				92	13.80		
D. Experience in Related Fields		.20				95	19.00		
E. Record of Past Performance		.20				90	18.00		
1. Attitude Toward Correcting Problem	.40			85	34				
2. Adherence to Delivery Schedules	.40			85	38				
3. Cost Overrun History	.20			90	18				
F. Geographic Location		.10				100	10.00		
Part III: Technical Approach			.50					88.20	44.1
A. Reliability		.20				70	18.00		
B. Manageability		.10				80	8.00		
C. Productivity and Economy		.10				82	8.20		
D. Technical Data and Documentation		.15				85	12.75		
E. Overall Size and Weight		.25				Inc.	-----		
F. Power Consumption		.20				96	17.20		
OVERALL RATING	//////////	//////////	//////////	//////////	//////////	//////////	//////////	//////////	87.1

FIGURE IV-7: SAMPLE WEIGHTED FACTORS FORM: COMPLETED. This illustration shows a completed evaluation of Proposal A, focusing on the offeror's record of past performance (Part II-E) in detail, and summarizing the scores of all other evaluation criteria. In a real procurement, the form would have to be expanded to provide room for scoring the component criteria of each evaluation factor.

FIGURE IV-7 (Continued)

INSTRUCTIONS

1. Fill in the title of the procurement project.
2. Identify the proposal by letter or number.
3. Sign your name.
4. Fill in the date of the evaluation.
5. Record the weights assigned to each evaluation criterion in Column 1, the weights assigned to each evaluation factor (group of evaluation criteria) in Column 2, and the weights assigned to each part of the proposal (group of evaluation factors) in Column 3.
6. Review the acceptability of the proposal with respect to each evaluation criterion, using either an Evaluator Scoring Guide (Figure IV-4 or the Ratio technique (Figure IV-5) for guidance in assigning a score to each evaluation criterion.
7. Record the Raw Scores assigned to each evaluation criterion in Column 4.
8. Calculate the Weighted Score of each evaluation criterion by multiplying the Raw Score (Column 4) by its corresponding weight (Column 1), and record the products in Column 5.
9. Calculate each Factor Score by summing the Weighted Scores of component evaluation criteria (Column 5) and dividing the total by the sum of the corresponding weights (Column 1). Record the results in Column 6.
10. Calculate the Weighted Factor Scores by multiplying the Factor Scores (Column 6) by the corresponding weights (Column 2), and record the products in Column 7.
11. Calculate each Part Score by summing the Weighted Factor Scores of component factors (Column 7) and dividing the total by the sum of the corresponding weights (Column 2). Record the results in Column 8.
12. Calculate the Weighted Part Scores by multiplying the Part Scores (Column 8) by the corresponding weights (Column 3), and record the products in Column 9.
13. Calculate an Overall Rating by summing the Weighted Part Scores (Column 9).

*This illustration shows a partially completed evaluation of Proposal A, focusing on the offeror's record of past performance (Part II-3). Completion of columns 5-9 is illustrated in Figure IV-7. Note that in a real procurement this form would have to be expanded to provide room for scoring the component evaluation criteria of each evaluation factor.

rankings of the offers made by each evaluator that identifies how many evaluators ranked each offer first, second, third, and so forth. Close examination of a scatter chart may reveal that a certain group of offers are ranked high by all, or almost all evaluators. In Figure IV-8, for example, offers M, G, and C are all ranked no worse than fourth, while no other offer is ranked better than third. Offers M, G, and C, therefore, are obviously the three best offers. Furthermore, Offer C appears to be the best of the three.

Step 4: Prepare an Evaluation Report

The procurement team should review the composite ranking of the bids or proposals and, depending upon the procurement strategy, recommend:

- Awarding the contract to a particular contractor in accordance with his bid or proposal (if the procurement strategy is One-Step or Two-Step Sealed Competitive Bidding, One-Step or Two-Step Design Competition, or Prequalified Design Competition).
- Initiating simultaneous negotiations with three to five particular firms (if the procurement strategy is Competitive or Parallel Negotiations).
- Initiating negotiations with a particular firm (if the procurement strategy is Sequential or Sole-Source Negotiations).

This award recommendation should be part of an Evaluation Report that summarizes the top three to five offers and discusses the rationale for the award recommendation. The Evaluation Report should also discuss any significant issues, problems, or questions that affected the ranking. In particular, this Report must describe the rationale for recommending other than the lowest cost offer, the rationale for recommending other than the offer with the highest overall rank, and any trade-

Offer Code	RANK															Composite Rankings
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
M	1	2	3	1												3
G	2	3	1	1												2
L			1		1	3	1		1							6
C	4	2		1												1
A			1	3	3											4
N						2	3	1	1							7
F			1	1	3	1	1									5
B						1	2	4								8
O								2	4	1						9
H										2	4		1			11
J											2	4		1		12
D									1	4	1	1				10
I												2	2	1	2	13
K													4	2	1	14
E														3	4	15

Figure IV-8: SAMPLE SCATTER CHART. This chart identifies how many evaluators ranked each of 15 offers first, second, third ... fifteenth. For example, one evaluator ranked Offer M first, two evaluators ranked it second, three ranked it third, and one ranked it fourth. On the other hand, three evaluators ranked Offer E fourteenth, and four ranked it dead last. The initial ranking of the offers, shown in the leftmost column, can be taken from any one evaluator. The composite ranking, shown in the rightmost column, is determined by examining the chart -- the best overall offer is usually the one ranked first by more evaluators than any other offer (i.e., Offer C); Offers G and M are the only other offers ranked first; thus they are ranked two and three overall; no other offers were ranked first or second, and Offer M has more number 3 rankings than any other offer, so it is ranked fourth overall ... Furthermore, Offer C appears to be the best of the three.

offs that were considered. The Report should also briefly describe the deficiencies in the remaining bids or proposals. A complete Evaluation Report should include the following information:

- o A Problem Statement or description.
- o The Award Recommendation and Rationale.
- o Any unresolved problems or issues with the recommended bid(s) or proposal(s).
- o A listing of who was solicited, and how.
- o The evaluation criteria and weights.
- o Summaries of the best bids or proposals.
- o The completed evaluation forms.
- o The individual and composite rankings.

This Evaluation Report should be used to present the results of the evaluation to the appropriate decision-maker(s) for their approval. The Report can also be used to explain the award decision to the press, internal auditors, unsuccessful respondents, and anyone else interested in the details of the award decision (assuming that negotiations are unnecessary). The Evaluation Report also serves as a major information source for negotiators, and as a permanent record of the procurement effort.

SECTION V -- NEGOTIATION AND AWARD

This Section discusses how to prepare for contract negotiations, how to negotiate with a prospective contractor or supplier, and how to award a contract. The objectives of this negotiation and contract award phase are:

- To collect sufficient data and information to make final decisions on selecting an offeror to receive a contract award;
- To document the basis for this selection in order to protect the government against unfounded claims and criticisms;
- To prepare and execute the necessary contractual documents that represent the best interests of the government and express the essence of the mutual agreement between the government and the contractor; and
- To notify unsuccessful offerors of the basis for the award decision, express gratitude for their efforts, and indicate how they might improve their responses for future requirements.

Contract negotiations are appropriate only if the procurement strategy calls for them. They are used to clarify ambiguities in specific aspects of a bid or proposal; to gain a better understanding of the offeror's capability, proposed approach, knowledge, or experience; or to reach a mutual agreement on price and other business terms. Skip directly to Management Approval Point #6, if the procurement strategy is One-Step or Two-Step Sealed Competitive Bidding, One-Step or Two-Step Design Competition, or Prequalified Design Competition.

MANAGEMENT APPROVAL POINT #5

Top management must have an opportunity to review the Evaluation Report prepared earlier in Task 11, Step 4. Management approval is essential at this time because the procurement team is, in effect, eliminating all but a few firms from further consideration. Top management should review the Evaluation Report and seek answers to the following questions:

- Did the evaluators review the bids or proposals in an objective and impartial manner?
- Were there any irregularities in the evaluation process that may have influenced the recommendations contained in the Evaluation Report?
- Do the evaluation recommendations adequately reflect the jurisdiction's equal opportunity guidelines, procurement policies, or other "political" considerations?

Top management's decision -- either to approve the evaluation recommendations or to revise the listing of firms with which to begin negotiations -- must be documented. The decision and the rationale for it should then be attached to the Evaluation Report.

TASK 12: PREPARE FOR NEGOTIATIONS

State and local governments frequently meet with potential contractors to present their case for reducing prices, changing delivery schedules, making tradeoffs between quality and price, or adjusting other elements of a proposal. Experience suggests that careful preparation is important in order to strengthen a jurisdiction's bargaining position relative to the prospective contractor or supplier's bargaining position. Prospective contractors or suppliers are likely to have the stronger bargaining position because information about budget allocations, program needs, and political pressures are usually public knowledge. Therefore, personal charm, interpersonal skills, and negotiating tactics are inadequate substitutes for careful preparation.

The procurement team should follow seven steps in preparing for these negotiations:

1. Formulate negotiating objectives.
2. Select the negotiating team.
3. Review the procurement.
4. Brief the negotiators.
5. Determine the relative bargaining positions of the jurisdiction and each prospective contractor.
6. Select a time and place for the negotiations.
7. Prepare a meeting agenda.

Step 1: Formulate Negotiating Objectives

The jurisdiction's overall objective in entering negotiations is to reach a contractual agreement that is most advantageous for itself after considering price and other factors such as the delivery

schedule, product quality, support services, contract administration procedures, and acceptance or benchmark tests. The procurement team should formulate specific objectives in these or other areas to guide negotiations with each potential contractor or supplier.

The procurement team should begin by reviewing the Evaluation Report prepared earlier in Task 11, Step 4 -- concentrating on the shortcomings of each proposal still under consideration. Team members should then determine, on a proposal-by-proposal basis, whether it is in the jurisdiction's best interests to seek improvements in any area. Based on this analysis, the procurement team should describe the improvements sought in each proposal using specific, well-defined, measurable objectives such as the following:

- Reduce the maximum time to complete image interpretation and data extraction from three months to two months.
- Shift manpower allocations so that the study places twice as much emphasis on inventorying water resources.
- Increase training service to an equivalent of 20 person-days.
- Set aside ten percent of all subcontracts for minority contractors.
- Increase progress reporting from a bimonthly basis to a monthly basis.
- Require the final product to pass various tests.
- Reduce the time of photography from between September 15 and November 15 to between October 15 and November 15.
- Reduce the profit factor from twelve percent to seven percent.

Finally, the procurement team should prepare arguments, again on a proposal-by-proposal basis, to support their position that improvements are warranted.

Step 2: Select the Negotiating Team

During negotiations, a jurisdiction may be represented by a single negotiator or by a negotiating team. The usual advantages cited in favor of a single negotiator are that this choice:

- Pointedly underscores the negotiator's sole responsibility and accountability for the outcome of negotiations.
- Requires that the negotiator be fully familiar with all managerial, technical, legal, and business aspects of the proposed contract.
- Precludes the possibility that differences of opinion may arise among team members at the negotiation table, thereby weakening the jurisdiction's position.
- Thwarts company negotiators in their effort to direct negotiations to the most sympathetic member of the jurisdiction's team.

Despites these arguments, negotiating teams are becoming more and more prevalent in large, complex, expensive, and important procurements. This trend exists for several reasons:

- It is frequently impossible for a single negotiator to be thoroughly familiar with all the pertinent aspects of a procurement, especially those dealing with the highly involved technical considerations of remote sensing, substantial jurisdiction facilities or property, substantial subcontracting, or shared responsibility with line agencies for post-award decisions (e.g., design approvals, change orders, etc.).
- A negotiating team gives the jurisdiction a greater range of managerial, technical, legal, and business capabilities with which to counter the contractor or supplier's arguments than would be possible if only a single negotiator were used. A team composed of experts in several fields may also more readily expose factual errors made by the contractor or supplier, thus putting him or her on the defensive.
- The advance and defense of a jurisdiction's bargaining positions by several persons produces a psychological advantage in favor of the jurisdiction.

- The use of a negotiating team spreads the physical burden of negotiations among several individuals, thereby reducing fatigue and the judgmental errors that fatigue may cause.

- The availability of several persons, each with specialized capabilities and differing perspectives, can increase the effectiveness of pre-negotiation planning and simplify the resolution of problems arising during negotiations.

- The advantages usually cited in favor of using a single negotiator can also be claimed by a negotiating team if the team is lead by a strong negotiator.

Each negotiating team must be led by an experienced negotiator. If the jurisdiction lacks an experienced negotiator, one alternative is to borrow such an individual from a local business, university, or public interest group. Another alternative is to enroll a negotiator in a short training program on the art of negotiations. For information on how to contact private firms offering training programs on procurement negotiations, refer to Table V-1.

The composition of the entire negotiating team depends upon the objectives of the negotiations, size of the jurisdiction, value of the procurement, and its complexity. In addition to an experienced negotiator, each team should include a remote sensing requirements specialist, a procurement specialist, someone with top management's perspective, and appropriate technical support specialists -- such as photointerpreters, field surveyors, cartographers, as well as an auditor and a lawyer at times. While each of these perspectives is necessary, it is possible that one individual can fill several roles on the negotiating team.

Step 3: Review the Procurement

Perhaps the most important thing that a negotiating team can do

TABLE V-1 -- SOURCES OF NEGOTIATION TRAINING

FOR INFORMATION ABOUT:	
One-day negotiating seminars and a 12-hour video-taped seminar program called "Effective Negotiating" (including a one-hour preview tape), CONTACT:	• Mr. Gary Karrass Center for Effective Negotiating 2066 Westwood Boulevard Los Angeles, California 90025 (213) 476-4554
Three-day seminars on "Successful Negotiating", CONTACT:	• AMR International 1370 Avenue of the Americas New York City, New York 10019 (800) 223-6787
Two and one-half day seminars on "Negotiating Skills" and a correspondence course called Negotiating Your Way to Success CONTACT:	• American Management Associations 135 W. 50th Street New York City, New York 10020 (212) 586-8100
Additional training programs, CONTACT:	• Don Sowle Associates, Inc. 1911 Jefferson Davis Highway Arlington, Virginia 22202 (703) 979-4360 • Sterling Institute, Inc. 1010 Wisconsin Avenue, N.W. Washington, D.C. 20007 (202) 337-4000 • Harbridge House, Inc. Offices in Boston, Chicago, Denver, Los Angeles, New York, and Washington, D.C.

to prepare for negotiations is to review the entire procurement -- including the original problem or need statement, the solution requirements and specifications, the evaluation criteria, the negotiating objectives, and each proposal still under consideration. In conducting this review, team members should individually seek to understand:

- How the requirements have changed over time.
- What experiences other jurisdictions have had in procuring the same or similar remote sensing products or services.
- What remote sensing technologies will be used to obtain the desired product and what type of image processing interpretation and analysis methods will be used.
- What technical and managerial problems must be solved by the contractor.
- Which problems appear to be critical.
- How much effort is necessary to overcome these problems.
- What work can or must be done by subcontractors.
- How much support the jurisdiction plans to provide the contractor.
- What assumptions can be made in estimating costs.

Step 4: Brief the Negotiators

Before any negotiations begin, the negotiator or the negotiating team must fully understand:

- The background or history of the procurement.
- The objectives of the procurement.
- The negotiating objectives for each proposal.
- The function of each team member.
- The steps in negotiating an agreement.
- What each team member is and is not expected to do.

- How the team members are expected to communicate with each other.
- Who will represent the contractor or supplier.
- What roles the contractor or supplier's bargaining position are expected to play.

Only one person should actually negotiate with a prospective contractor, even when the jurisdiction is represented by a negotiating team. This chief negotiator must know when to call on the team members and how to use their skills to the best advantage. He or she must continually exercise the positive control necessary to both ensure effective communications and maintain a strong position. Other members of the negotiating team should be instructed to listen attentively, note any opportunities for strengthening the jurisdiction's position, and answer any questions directed to them by the chief negotiator.

Two or more negotiating teams may be necessary when the procurement strategy calls for Competitive or Parallel Negotiations. If multiple teams are required, one joint briefing is sufficient to cover the background, history, and objectives of the procurement, and the overall negotiating process. Each team should then conduct a separate briefing dealing with the proposal(s) they are to consider, the corresponding negotiating objectives, their roles in the negotiations, and the contractor's negotiating team.

Step 5: Determine the Relative Bargaining Positions

After the negotiating team has been briefed, team members should determine the relative strength or weakness of the jurisdiction's

bargaining position in relation to each prospective contractor or supplier's bargaining position. This relationship can be influenced by many tangible and intangible factors, including:

- o The amount of competition for the contract.
- o The intensity of the contractor or supplier's desire for the contract.
- o Time pressures on the jurisdiction and contractor to seek agreement.
- o External pressures -- regulatory, legal, political, and public -- that one party can bring to bear against the other.

Finally, there are many regulatory, legal, political, and public pressures that work to the advantage of one party or the other. External pressures that work to the jurisdiction's potential advantage include:

- o Procurement regulations that state the rules and establish the framework within which the negotiator must operate, thereby allowing the negotiator to place the blame for certain positions taken on a third party beyond his or her control.
- o Administrative policies that require top management approval of negotiated agreements.
- o The jurisdiction's reputation in a large market and the contractor's or supplier's awareness that his conduct on one procurement may influence his ability to secure future business from the jurisdiction.
- o The weight of public opinion against a contractor or supplier who attempts to take advantage of the jurisdiction -- wasting taxpayers' money and jeopardizing local program efforts.

External pressures that may strengthen the contractor's bargaining power include:

- o Procurement regulations that limit negotiations to specific issues or items, or otherwise limits the flexibility of negotiations.

- o Pressures exerted by members of a council or legislature for business for their constituents or political allies.

- o Pressures exerted by the eventual user to have a specific contractor or supplier perform the desired work.

- o Pressures created by a favorable precedent if, for example, the contractor or supplier was able to secure concessions from the jurisdiction on past contracts.

- o Pressures created by company policy that, for example, might require all contracts to use a fixed price base, to use standard prices, or not to negotiate price.

Step 6: Select a Time and Place

Negotiations should be held at the jurisdiction's offices at a mutually agreeable time. The jurisdiction gains the following advantages by holding negotiations on its premises:

- o There is often a psychological advantage in having the contractor or supplier (the seller) come to the jurisdiction (the buyer).

- o On most procurements, the jurisdiction saves the time, money, and effort involved in traveling to another location.

- o Members of the negotiating team can keep in touch with their other work.

- o The availability of technical, legal, and other specialists is ensured, assuming they are needed.

- o The pressure on the chief negotiator to conclude the negotiations in order to return to his office is reduced and, if an acceptable agreement cannot be reached, the contractor or supplier will be the one who must return for a future bargaining session.

- o If an impasse occurs, a higher authority is more likely to be available for consultation.

- o Team members will not be faced with awkward situations such as accepting lunch at, or being transported to and from, the contractor or supplier's offices.

Step 7: Prepare a Meeting Agenda

One of the most difficult aspects of a negotiation is to confine the discussions to important issues and avoid irrelevant subjects. The chief negotiator should, therefore, prepare a detailed (private) meeting agenda that lists the deficiencies or problems in each proposal, the order in which to discuss these deficiencies or problems the rationale for the jurisdiction's position on each issue, the information needed from the contractor or supplier on each issue, and the jurisdiction's tentative opening and final position on each issue.

The jurisdiction's opening position on any issue should be relatively extreme in order to avoid foreclosing greater concessions from the contractor and to provide room for bargaining. However, this position must be justifiable or else the jurisdiction will appear to be unreasonable and/or arbitrary, and its negotiator will be placed on the defensive. The jurisdiction's closing positions should have been defined in Step 1.

The detailed (private) agenda discussed above must not be disclosed to the contractor or supplier. Rather, the negotiating team should prepare a less detailed (public) agenda for use during the meeting itself. This agenda should be written in fairly general language, cover the issues and their sequence, and should not reveal the jurisdiction's position. Also, it should ideally help put the contractor or supplier in a frame of mind to make concessions.

TASK 13: NEGOTIATE AN AGREEMENT

The negotiating team should now be ready to sit down with a potential contractor or supplier to negotiate an agreement. In Competitive Negotiations, the jurisdiction usually negotiates simultaneously with the offerors of the best two to five technical proposals, although negotiations may be limited to one firm if one proposal is clearly superior to all others. Simultaneous negotiations with two to five firms are also used with the Parallel Negotiation strategy. Sequential Negotiations involve only one firm at a time, beginning with the most qualified firm. Either an agreement is reached with this firm, or the negotiations are terminated and begun again with the next most qulaified firm. Sole-Source Negotiations obviously involve only one prospective contractor or supplier.

Negotiations do not lend themselves to step-by-step game plans. Therefore, the chief negotiator must be flexible and sensitive to the contractor's or supplier's arguments and approaches. Too great a dependence upon a detailed strategy or preconceived tactics may backfire if the contractor or supplier says or does the unexpected. There are several general steps, however, that the chief negotiator should follow:

1. Initiate discussions on the relevant issues.
2. Sell the jurisdiction's position on these issues to the contractor or supplier.
3. Conclude negotiations with a summary covering all key points.
4. Prepare an award recommendation.

The negotiating team should follow the general guidelines presented in Table V-2 throughout the ensuing negotiations. For additional

TABLE V-2 -- NEGOTIATION GUIDELINES

DON'T

DON'T tip your hand too early.

DON'T get so bogged down in details that the overall objectives are lost.

DON'T try to prove the contractor wrong.

DON'T try to make the contractor's negotiator look bad in the eyes of his superiors.

DON'T dictate to the contractor with statements like "You'll have to do this or that."

DON'T ridicule or insult the contractor or his representatives with statements like "You're not qualified to negotiate."

DON'T establish a standard negotiation strategy to be used again and again.

DON'T be unyielding except on really important issues.

DON'T be intimidated.

DON'T be on the defensive about your position.

DON'T let the contractor take over completely.

DON'T keep on negotiating when you are out of facts and the situation gets irrational or emotional.

DO

DO NEGOTIATE at your offices.

DO ISOLATE members of the contractor's team by seating members of your negotiation team between them.

DO NEGOTIATE with those who can make concessions.

DO REMAIN silent at times and let the contractor talk himself into a better agreement than you expected.

Table V-2 (continued)

DO KNOW what you can expect to gain by negotiating and keep the target in mind.

DO NEGOTIATE for the long-term advantage, not the short-term advantage.

DO KNOW your facts, figures, data, and other information and be sure they are accurate.

DO DIVERT attention away from your weak points.

DO CALL a recess or arrange for lunch if the talks hit a snag.

DO USE specialists to help evaluate new offers or information.

DO ALWAYS be fair.

DO what you say you will.

DO KEEP your relationships with a contractor on a dignified, business-like and impersonal basis so that you can be absolutely objective in your negotiations with him.

DO BE courteous, considerate, pleasant, and, if necessary, firm.

DO BE tactful and diplomatic; know how to influence an issue without being adamant or domineering.

DO KEEP control over your emotions.

DO STRESS the strong points of the contractor's proposal before noting your concerns.

DO ASK the right questions; a question can be far more disarming than a challenge.

DO STOP talking once you've won your case.

assistance, the team may also find it helpful to review Fundamentals of Negotiating by Gerard I. Nierenberg (New York: Hawthorn Books, Inc., 1977).

Step 1: Initiate Discussions

The negotiations should begin with an introduction of the participants and a presentation of the meeting agenda. The chief negotiator should then invite the prospective contractor or supplier to raise any other issues of concern to him or her.

The jurisdiction is usually responsible for initiating the negotiations because the contractor's or supplier's proposal usually presented his or her initial position on all issues. Thus, once the preliminaries are finished, the chief negotiator should raise the first issue on his agenda, describe the jurisdiction's concern or reservation, and ask the contractor or supplier to respond. If the response meets or exceeds the jurisdiction's negotiating objectives, then it should be immediately accepted and recorded in writing for future reference. However, the contractor or supplier is more likely to provide an unsatisfactory or vague response, or to ask for additional time to prepare a response. In this case, the chief negotiator should attempt to determine the reasons for the contractor's particular response and the relative importance of the issue to him or her. The chief negotiator is then in a better position to sell the jurisdiction's position on the issue.

The same approach should also be followed with issues on the contractor's or supplier's agenda. The chief negotiator should press the contractor or supplier to describe each issue as specifically as

possible in order to determine his specific negotiating objective. At the same time, the chief negotiator should decline to respond until he clearly understands the request, its impact, its significance and its cost.

Step 2: Sell the Jurisdiction's Position

The jurisdiction's position on each issue is sold by exchanging offers and counteroffers on an issue-by-issue basis. Success depends both on facts and relative bargaining power; logic alone will not necessarily persuade the contractor or supplier to accept the jurisdiction's position. Thus, the chief negotiator frequently finds it necessary to employ various negotiating tactics in an effort to present an accurate picture of the jurisdiction's concerns and to improve the jurisdiction's relative bargaining power. The chief negotiator should, however, never turn the negotiating process into an adversary proceeding.

The chief negotiator should rely upon the detailed (private) agenda (prepared in Task 12, Step 7) and the views of the other team members during the exchange of offers and counteroffers. The jurisdiction's initial position on most issues should be taken from this agenda. The chief negotiator should then advance intermediate positions and introduce new issues based on his reading of the words, mannerisms, and mood of the negotiations. He should also call recesses to allow the entire negotiating team to assess the ramifications of the contractor or supplier's counteroffers and to prepare positions for new issues raised by the contractor or supplier. Finally, the negotiating team should keep track of the financial and nonfinancial consequences resulting from additions, deletions, or revisions to the initial proposal.

When logic does not seem to be moving the negotiations toward agreement on an issue, the chief negotiator may wish to create some progress by making the contractor or supplier appear unreasonable, by placing him on the defensive; by referring to a third party; by appealing to emotions; or by using straw issues, walkouts, or recesses. The chief negotiator should also be on the lookout for instances where contractor or supplier is using these same tactics. For additional assistance, refer to the over 200 strategies and tactics useful in contract award negotiations that are described in Give and Take: The Complete Guide to Negotiating Strategies and Tactics by Chester K. Karrass (New York: Thomas Y. Crowell Co., 1974).

The chief negotiator may or may not be able to sell the jurisdiction's position on an issue. If an agreement can be reached, it should be recorded in writing and reviewed by both parties before the next issue is addressed . If an agreement cannot be reached, the two parties should expressly agree to disagree and move on to the next issue. In moving from one issue to the next, the chief negotiator should be extremely careful to ensure that both parties fully understand the status of their agreement on the current issue -- temporary disagreement, conditional agreement, final agreement, etc.

Step 3: Conclude the Negotiations

When an agreement is finally reached, the chief negotiators for both parties should shake hands on it, and their verbal understanding should be recorded in a written memorandum signed by both parties. The memorandum should describe each issue raised during the

negotiations and how each was resolved in clear, simple, and objective English. While the agreement is still subject to approval by top management, this joint memorandum ensures that no important conditions are overlooked or misunderstood. At this time, all other negotiations sould be terminated.

When negotiations with a prospective contractor or supplier are terminated without an agreement, the negotiating team should prepare a permanent Negotiation Record and a formal termination letter. The Negotiation Record should be part of the permanent file on the procurement; it should include the original proposal and document all agreements and unresolved issues. The formal termination letter should be mailed as soon as possible, and it should clearly state the reasons for terminating the negotiations and return any bonds posted with the proposal.

Step 4: Prepare an Award Recommendation

When an agreement has been reached, the chief negotiator should prepare a written Award Recommendation drawing upon information in the technical and cost proposals, Evaluation Report, Memorandum of Understanding, and other Negotiation Records. This Award Recommendation should clearly describe the recommended proposal and the major factors leading to its selection. It should also:

- Describe the changes made to the original proposal during the negotiations.
- Document the rationale for any compromises in the jurisdiction's negotiating objectives.
- Discuss the other contractor or suppliers with whom negotiations were conducted and the unresolved issues that prevented an agreement with them.

- Include copies of the winning proposal and Memorandum of Understanding.

This Award Recommendation should become part of the permanent file on the procurement, and it should be used to present the results of the negotiations to the appropriate decision-maker(s) for their approval. This document can also be used to explain the award decision to the press, internal auditors, unsuccessful contractors or suppliers and any other interested party.

MANAGEMENT APPROVAL POINT #6

Recommendations by the procurement manager and chief jurisdiction negotiator are just that -- recommendations. They must still be approved by the appropriate decision-makers, and contract documents must still be executed before a binding agreement exists. In deciding whether or not to approve the Award Recommendation, or in the absence of negotiations the Award Recommendation contained in the Evaluation Report, top management should seek answers to the following questions:

- Does the jurisdiction still need the product or service?
- Do the jurisdiction's requirements remain the same? If not, should the jurisdiction cancel the procurement, revise the specifications, and go through the procurement process again?
- Were there any irregularities in the procurement process that might have affected the Award Recommendation?
- Does the jurisdiction have the requisite authority to enter into the recommended agreement?
- Does the jurisdiction have the financial resources to pay for the product or service?

TASK 14: AWARD THE CONTRACT

The procurement team must now ensure that the contractual specifications and/or the Memorandum of Understanding are translated into a legally binding contract between the jurisdiction and contractor. This task involves three steps:

1. Prepare the contract documents.
2. Execute the contract documents.
3. Notify unsuccessful offerors that the contract has been awarded.

Step 1: Prepare the Contract Documents

The initial draft of the contract documents should be prepared by a lawyer who is familiar with the contractual specifications, the winning bid or proposal, and, if negotiations were conducted, the Memorandum of Understanding. These draft contract documents should then be reviewed by other members of the procurement team -- including the procurement manager, requirements and procurement specialists, and chief negotiator -- to ensure that they accurately reflect the terms and conditions of the procurement as they know them. In particular, this review should compare the draft contract documents with the following documents:

- Technical specifications.
- Contractual specifications.
- Winning bid or proposal.
- Memorandum of Understanding.

The draft should then undergo final review by the jurisdiction's legal staff.

Step 2: Execute the Contract Documents

Two copies of the unsigned contract documents should be sent to the contractor or supplier as soon as they have been approved in final form by the procurement manager. The transmittal letter should ask the contractor or supplier to sign and return the contracts, post any required bonds, and supply all necessary certifications and permits prior to a specific date. The appropriate jurisdiction official should sign both contracts only after these conditions are satisfied. Last, one copy of the fully executed contract should be sent to the contractor or supplier.

Step 3: Notify Unsuccessful Offerors

After the contract is signed by both parties, the jurisdiction should so inform the unsuccessful bidders or proposers. A formal letter should be written that names the successful contractor or supplier and thanks the unsuccessful firms for their time and effort. The letter should also extend an offer to debrief the unsuccessful offeror at a mutually agreeable time. Such a debriefing:

- Responds to the contractor or supplier's natural interest in knowing why he was unsuccessful.
- Assists the unsuccessful contractor or supplier in submitting more acceptable offers on future procurements.
- Allows the jurisdiction to develop and maintain good relationships with contractors or suppliers who may help to meet future procurement needs.

In debriefing unsuccessful offerors, the procurement manager must exercise care to ensure that these unsuccessful offerors are not given any proprietary or confidential information. Furthermore, they

should not be led to think that an appeal of the award decision to higher authorities would be successful.

SECTION VI -- CONTRACT ADMINISTRATION

The procurement process does not end with the award of a contract. The contractor's performance must be continually monitored, the contract itself may be amended in response to unforeseen problems, and the contract must eventually be closed-out or terminated. In performing these tasks, the procurement team should:

- Assure a mutual understanding of the rights, obligations, and responsibilities of both the contractor and the government under the contractual agreement.
- Provide the contractor with the support due him under the contract and otherwise uphold the contractual agreement.
- Correct any problems faced by the contractor in meeting his or her obligations and responsibilties.
- Implement any contract changes desired by the government.
- Protect the government's interests in the event of default by the contractor or contract termination.

This contract administration phase requires the special expertise offered by a requirements specialist and a procurement specialist. A financial expert, lawyer, and negotiator may also be required to handle special situations.

TASK 15: MONITOR CONTRACT PERFORMANCE

Performance monitoring allows the jurisdiction to diagnose problems that may lead to work change orders, schedule slippages, cost overruns, and/or unacceptable product quality. Three steps should be taken to guard against those problems:

1. Designate a Contract Administrator.
2. Establish Administrative controls.
3. Monitor work progress regularly.

Step 1: Designate a Contract Administrator

One person must be given responsibility for administering the contract. This Contract Administrator should be the single focal point for all interactions between the contractor and the jurisdiction, and should be responsible for the following actions:

- Coordinating the flow of information between the contractor and the jurisdiction (while a free flow of information between the two is invaluable from a technical perspective, it frequently leads to improperly authorized, government-initiated changes that can be used by the contractor to make claims for additional compensation).
- Responding to all requests made by the contractor.
- Monitoring disbursements against the contractual budget.
- Monitoring actual procurement progress against the work schedule.
- Coordinating the delivery of data or services to the contractor in sufficient time to avoid delays.
- Authorizing all no-cost contract modifications and recommending all cost adjustments to the appropriate decision-makers.
- Reviewing and approving all contract deliverables.

The Contract Administrator should have a technical background to promptly diagnose problems in the acquisition, processing, interpre-

tation and presentation of remote sensing data, and a managerial background to effectively administer all financial, contractual, and managerial concerns. The primary alternative -- assigning technical responsibilities to one person, and financial and contractual responsibilities to another -- is less satisfactory because no one individual is responsible for comparing technical progress and contractual expenditures.

The jurisdiction's chief administrative officer, or someone else with the appropriate authority, must formally designate the Contract Administrator by name and clearly define his or her resonsibilities vis-a-vis the contract. This designation should be sent, by letter, to the contractor, user agency, purchasing agency, and all members of the procurement team so there can be no misunderstanding as to where the authority for administering the contract lies.

Step 2: Establish Administrative Controls

The Contract Administrator and the contractor's project manager should review the rights, obligations, and responsibilities of both parties soon after the contract is signed. During this review, they should again discuss all issues that were difficult to settle during negotiations since these issues are the most likely points for future disagreement. They should then review the following items:

- Communication channels between the jurisdiction and the contractor, designating specific personnel by name, title, responsibility, address, and telephone number.
- Major milestones, including the due dates for all contract deliverables and the provision of all property, material, and manpower by the jurisdiction to the contractor.
- Administrative and technical requirements for reporting work progress.

- o Administrative requirements for reporting expenses and procedures for progress payments or other financial arrangements.
- o Administrative and technical procedures for inspecting and accepting contract deliverables.
- o Administrative procedures for authorizing modifications to the contract.

Written progress reports are essential if the Contract Administrator is to maintain control over the project. Regular progress reports should describe actual progress during the current reporting period, deviations from planned progress, and problems anticipated in the next reporting period. Progress reports should also explain the reason(s) for these deviations (current and expected); outline what is being done to correct them; and indicate what assistance, if any, is required from the jurisdiction.

Control is facilitated by requiring the contractor to submit (1) a baseline schedule, for approval by the Contract Administrator, and (2) a comparison of actual progress to the baseline schedule with each written progress report. A baseline schedule is simply a bar chart listing the scheduled start and completion dates for each task and schedule in the project, plus the dates of special events such as the delivery of required products, services, reports, or other documentation. Progress is indicated by blackening in completed activities.

Cost controls are another means of determining whether the procurement is proceeding as planned. Cost controls warn the Contract Administrator of any problems the contractor may have in completing the required work within the contractual cost limits by showing the

relationships between actual and expected costs. Cost controls are also used with cost-reimbursement contracts as a means of noting deviations from target costs. The Contract Administrator can then suggest actions that will reduce these and future deviations thereby keeping actual costs as low as possible. Finally, cost control is maintained by requiring the contractor to submit (1) a baseline cost plan, for approval by the Contract Administrator, and (2) a cost status report with each written progress report.

Quality control is established by the test and inspection procedures written into the specifications and contract. The Contract Administrator should assign the responsibility for conducting these tests and inspecting all documents, products, and services to individual requirements specialists and technical support specialists. The Contract Administrator should also ensure that the tests and inspections are conducted in a timely fashion to avoid having the contractor hold the jurisdiction responsible for any delays in the delivery of the final product or service. Also, the Contract Administrator should review the results of every test or inspection procedure to determine the existence of any problems.

Other contractual controls are written into the contract documents. These controls regulate actions the contractor might take that affect the contractual relationship itself. For example, contracts frequently require the jurisdiction (i.e., the Contract Administrator) to approve all subcontracts and the assignment of claims.

Step 3: Monitor Work Progress

The Contract Administrator should be responsible for continually monitoring the work done by the contractor. He or she should carefully

study the written progress reports, cost status reports, and other administrative controls established in Step 2 in order to uncover existing or potential problems. At the first hint of schedule slippage, cost overrun, unacceptable quality, or any other problem, the Contract Administrator should evaluate the seriousness of the problem, judge the adequacy of the contractor's plans for correcting or avoiding the problem, and suggest further corrective action, as necessary. More specifically, the Contract Administrator should be responsible for:

- Ensuring the timely submittal of all progress and cost status reports.
- Comparing these reports with the baseline schedule and cost plans.
- Ensuring that the contractor receives the governmental support promised him in a timely fashion.
- Ensuring the timely delivery of all products, services, and documentation required by the contract.
- Ensuring that all quality control procedures (i.e., tests and inspections) are followed by the appropriate requirements and technical support specialists immediately after receipt of each contract deliverable.
- Reviewing the results of tests and inspections before closing-out the contract.

TASK 16: AMEND THE CONTRACT, AS NECESSARY

Contract amendments should be avoided whenever possible because they usually lead to price increases, schedule slippages, and other problems; nevertheless, unforeseen problems, circumstances, and events may make a contract amendment a necessity. To protect the jurisdiction's interest, contract amendments should not be discussed with the contractor (either in person, by telephone, or in writing) without the prior knowledge and explicit approval and/or direct supervision of the Contract Administrator.

The Contract Administrator can maintain control over contract amendments by requiring that all proposed amendments follow these six steps:

1. Draft the contract amendment.
2. Evaluate the proposed contract amendment.
3. Price the proposed amendment.
4. Issue a formal change order under a unilateral change clause (in emergencies only).
5. Negotiate an acceptable agreement.
6. Execute the contract amendment.

Step 1: Draft the Contract Amendment

A contract amendment may be proposed by either the jurisdiction or the contractor. Regardless of who proposes an amendment, the amendment should be written in the actual language that will be inserted into the contract itself. Supporting documents should answer the following questions:

- What are the expected disadvantages of the amendment?
- How can the amendment benefit the procurement?
- How critical is the amendment to the success of the procurement?
- What unforeseen circumstances, problems, or events make the amendment necessary?
- What tasks and steps will need to be added, deleted, or changed to implement the amendment? Why are these modifications necessary?
- What impact will the amendment have on requirements for manpower and materials?
- What impact will the amendment have on requirements for governmental support, evaluation, and testing?
- What impact will the amendment have on direct labor costs, overhead costs, expenses, or profits?
- What impact will the amendment have on the ability to complete the contract on schedule?

Step 2: Evaluate the Proposed Contract Amendment

The Contract Administrator should review all draft contract amendments and supporting documents and decide whether they merit further consideration. Since a detailed evaluation of an amendment's impact and cost may take some time, the Contract Administrator should consider issuing a formal, written directive ordering the contractor to stop or slow work on specified tasks until further notice is given.

The Contract Administrator should draw upon the skills of appropriate requirements specialists and technical support specialists in evaluating the proposed contract amendment. The evaluation itself should focus on the advantages and disadvantages of the proposed amendment:

- Is each benefit cited in the supporting documents true and desirable?

- How significant are the amendment's limitations?

Additional questions relating to the feasibility of the proposed amendment are provided in Task 3, Step 6.

Once the Contract Administrator reaches a decision as to the desirability of the proposed amendment, he should proceed as follows:

- If the proposed amendment does not merit further consideration, then a formal letter rejecting the proposal and specifying the reason(s) for this decision should be sent to the contractor.

- If a desirable amendment was proposed by the contractor, it should be independently priced (Step 3) prior to negotiating an acceptable agreement (Step 5).

- If a desirable amendment was proposed by a government employee, it should be revised to incorporate the recommendations of the reviewers and to delete the cost estimate before being formally transmitted to the contractor. The transmittal letter, signed by the Contract Administrator, should direct the contractor to assess the merits of the proposed amendment and submit a priced counter-proposal. This counter-proposal should then be independently priced (Step 3) prior to negotiating an acceptable agreement (Step 5).

- If there is not enough time for adequate negotiations and the contract contains a unilateral change clause, the Contract Administrator may price the amendment (Step 3) and issue a formal change order (Step 4) before negotiating an acceptable agreement (Step 5). However, this option should be used only in emergencies since it puts the jurisdiction at a great disadvantage in any contract amendment negotiations.

Step 3: Price the Amendment

The next step is to develop an independent cost estimate for the contract amendment. This cost estimate should be prepared jointly by the Contract Administrator and appropriate requirements and technical support specialists, following the cost estimating guidelines provided in Task 3, Step 5.

In developing a cost estimate, the original contract price should be adjusted to reflect work that is added to or deleted from the contract. This adjustment may be made using one of three methods:

- Price the completed work that is being deleted from the contract at the original contract rates and new work that is being added to the contract at current or projected rates.
- Determine the net change in the work requirements for each labor category, type of material, type of facility, and other cost factors, and price net reductions at the original contract rates and net additions at current or projected rates.
- Determine uncompleted work that is being deleted from the contract at current or projected labor and overhead rates and the original contract profit rate, and new work that is being added to the contract at current or projected rates.

In analyzing the contractor's price proposal, the procurement team should be aware that it is always to the contractor's advantage to minimize the scope and costs of the work being deleted while maximizing the scope of the work being added. Therefore, the procurement team should analyze each labor and expense category in the original contract and in the new proposal to determine if the deleted work is underestimated or if added work is overestimated. They should check to see if the new proposal suggests a learning curve in estimating basic labor and expenses, and also check to see if the new proposal is based on actual costs instead of unadjusted projections of past trends. Major changes in the overhead and profit rates should be carefully validated, perhaps by an audit. The contractor should, however, be granted an increase in the profit rate if the added work is more complex and risky than the work that is being deleted. The

proposed cost plan should then be checked to ensure that it is reasonable, mathematically accurate, and consistent with generally accepted cost guidelines.

Step 4: Issue a Formal Change Order, If Necessary

If there is not enough time to negotiate a contract amendment and the contract includes a unilateral change clause, then the Contract Administrator may issue a formal change order. A formal change order is a letter, signed by the Contract Administrator, that is identified as a change order and describes changes to work tasks and the baseline schedule plan. Upon receipt of a change order, the contractor is immediately authorized to begin work on the changed tasks. Since work begins before a cost agreement is reached, this change order procedure can be expensive. THIS PROCEDURE IS NOT RECOMMENDED; its use should be limited to true emergency situations.

Step 5: Negotiate an Acceptable Agreement

Negotiating a contract amendment is similar to negotiating a sole-source contract. The Contract Administrator should carefully review Tasks 12 and 13 in Section V for detailed guidance on how to prepare for negotiations and how to negotiate an agreement.

Step 6: Execute the Contract Amendment

The execution of a contract amendment is a straight-forward procedure. The contract document incorporating the amendment should be prepared by a lawyer -- preferably the same lawyer who prepared the original contract -- based upon the Memorandum of Understanding. This

document should t'en be reviewed by the Chief Negotiator and Contract Administrator prior to obtaining the approval of the appropriate decision-maker(s), (e.g., the department head, change control board, chief administrative officer, or council). Next, the approved contract document should be sent to the contractor for his signature and, upon its return, signed by an authorized official of the jurisdiction. Finally, the Contract Administrator should formally direct the contractor to proceed with the contract as amended.

TASK 17: CLOSE-OUT OR TERMINATE THE CONTRACT

All contractual relationships must eventually be closed-out upon completion of all the work, or terminated prior to completion. A contract close-out is an administrative procedure involving formal acceptance of all contract deliverables and payment of the contractor's final invoice. A contract termination is generally a unilateral action that stops work on all or part of the contract for cause or convenience. A contract can also be terminated by mutual agreement in the same way that a contract is amended (see Task 16).

This task consists of three steps:

1. Close-out the contract.
2. Issue a Stop-Work Order.
3. Settle all claims.

Step 1 is performed only upon the satisfactory completion of all work. Steps 2 and 3 are performed only to terminate a contract for cause or convenience.

Step 1: Close-Out the Contract

A contract should not be closed-out until the Contract Administrator is satisfied that all contractual obligations have been met by the contractor. This occurs when two conditions have been met:

- The required products or services have been tested or inspected (see Task 15, Step 2).
- The results of these tests and inspections indicate that the required products or services comply with the technical specifications.

The Contract Administrator should formally notify the contractor, in writing, of the jurisdiction's final acceptance of all work products

as soon as these conditions are met. The contractor's final invoice should be paid. If, however, the previous payments and final invoice exceed the contract price or cost ceiling, then the Contract Administrator should ask the contractor to submit a revised invoice for an acceptable amount. Finally, all information relating to the procurement should be given to the procurement manager for final evaluation of the contract, contractor, and procurement.

Step 2: Issue a Stop-Work Order

All or part of the contract may be terminated for cause whenever the contractor refuses or clearly fails to meet contractual performance requirements. Common causes for default include: failure to deliver acceptable products or services; failure to meet scheduled delivery dates or contractual milestones; failure to perform according to other contractual terms and provisions; failure to resolve disputes or offer explanations on disputed terms, conditions, or requirements; or demonstrated lack of progress that is harmful to the jurisdiction.

The contractor should be warned that he or she is in default before work is actually stopped. This warning should consist of a formal letter from the Contract Administrator specifying how the contractor is in default and suggesting that these problems be corrected within a specified time frame such as ten or thirty days.

If a Stop-Work Order is required, it should be sent by telegram and followed up with a formal letter signed by the Contract Administrator. The telegram should convey:

- The effective date of the Stop-Work Order.

- The scope of the Stop-Work Order in terms of the specific work tasks being terminated (the entire contract or any portion of it can be covered by the Stop-Work Order).
- Instructions for stopping work, cancelling all purchase orders, and terminating all subcontracts.
- A request that the contractor acknowledge receipt of the Stop-Work Order.

The letter should convey any claim forms used in processing a contract settlement, provide instructions for filling out these forms, establish a due date for submitting them and present any additional information helpful in settling claims.

If the original contract includes a termination for convenience clause, the jurisdiction can also issue a Stop-Work Order for its own reasons, regardless of contractor performance. Federal Government contracts usually include a termination for convenience clause and there is nothing to preclude its use by state or local governments. When a contract is terminated for convenience, however, the jurisdiction makes full settlement for all in-process work, materials, equipment, and cancellation charges for outstanding service and supply contracts. A termination for convenience clause is usually invoked when program funding is cancelled, unexpected technological advances make the contracted products or services obsolete, or new constraints are imposed by political or administrative decisions.

Step 3: Settle All Claims

When a contract is terminated, the contractor may or may not be due any money, and the government may or may not be due monetary damages, materials, equipment, or partially completed work. The

settlement agreement is dependent upon whether the termination is for cause or convenience. Negotiations between the contractor and jurisdiction also influence its outcome.

When a contract is terminated for cause, the jurisdiction is only responsible for work that is satisfactorily completed. In fixed price contracts, the jurisdiction is generally liable only for work it had already accepted at the time of default. In cost-reimburseable contracts, the jurisdiction is generally liable for all allowable costs incurred up to the time when the contractor receives the Stop-Work Order.

When a contract is terminated for convenience, the jurisdiction is liable for all start-up costs, partially and fully completed work, and for any cancellation charges on outstanding purchase agreements or subcontracts. The contractor is liable for any costs incurred after receipt of the Stop-Work Order.

The process of negotiating a settlement after a Stop-Work Order has been issued is similar to negotiating a contract amendment except that an audit of the contractor's books may also be required. The contractor is requested to submit a settlement proposal that serves as the basis for the negotiations. The Contract Administrator should (1) formulate the jurisdiction's negotiating objectives, (2) select the negotiators, (3) review the amended contract with them, (4) review the contractor's performance with them, and (5) brief them on their roles and methods of communication during the negotiation sessions. The negotiating team should then (6) evaluate its relative bargaining power, (7) select a time and place for the negotiations, (8) prepare a meeting agenda, (9) initiate the discussions, (10) sell its positions, and

(11) conclude the negotiations with a signed Memorandum of Understanding. Further guidance in these areas is found in Section V, Tasks 12 and 13.

A formal settlement agreement is based on the Memorandum of Understanding and should be prepared by a government lawyer and reviewed by the Contract Administrator and Chief Negotiator. Approval of the settlement agreement should then be obtained from the approprite decision-maker(s). The Contract Administrator should transmit the approved agreement to the contractor with a letter requesting him to sign it and return it with a final invoice. Upon the return of the letter and invoice, an authorized official should sign the agreement for the government, the Contract Administrator should check to see that all terms of the agreement are met, and the invoice should then be paid. Finally, the Contract Administrator should turn over all written progress and cost status reports, the results of all quality control tests and inspections, a copy of the settlement agreement, and all other information relating to the procurement over to the procurement manager for a final evaluation of the contract, contractor, and procurement.

APPENDIX A

Sources of Technical Assistance

APPENDIX A-1

Federal Programs Offering User Assistance

Organization	Address	Services
NASA Remote Sensing Regional Applications Centers	(Northeastern, Middle Atlantic, and Great Lakes States) Dr. Philip Cressy, Head Eastern Regional Remote Sensing Applications Center NASA/Goddard Space Flight Center Greenbelt, Maryland 20771 (301) 982-2658 (Southern and Lower Midwestern States) Mr. Fred A. Patterson, Chief Applications & User Development Group Earth Resources Laboratory NASA/National Space Technology Laboratories NSTL Station, MS 39529 (601) 688-2042 (Western States, Alaska and Hawaii) Dr. Dale Lumb, Chief Technology Applications Branch NASA/Ames Research Center Moffett Field, CA 94035 (415) 965-6370	Orientation, training, cooperative projects and technical assistance to State and Local Governments interested in applying Landsat data to meet their information needs

USGS EROS Data Center (EDC)	User Services Unit EROS Data Center U.S. Geological Survey Sioux Falls, SD 57198 (605) 594-6511	The Data Center provides access to Landsat imagery, aerial photography acquired by U.S. Department of Interior and aerial imagery acquired by NASA research aircraft and satellites. Over 5 million images and photographs can be accessed through the Data Center. The Center also provides training in the interpretation and application of remotely sensed data. EDC sponsors orientation sessions, workshops, courses and cooperative demonstration projects as part of its training program.
EROS Applications Assistance Facilities	EROS Applications Assistance Facility U.S. Geological Survey National Space Technology Laboratories NSTL Station, MS 39529 (601) 688-3541 EROS Applications Assistance Facility U.S. Geological Survey 1925 Newton Square East Mail Stop 730 Reston, VA 22090 (703) 860-7871 EROS Applications Assistance Facility U.S. Geological Survey Geophysical Institute University of Alaska Fairbanks, AK 99701 (907) 497-7487 (Seattle operator will connect to Fairbanks number)	Applications Assistance Facilities contain microfilm copies of data archived at the EROS Data Center. Scientific personnel are available for assistance in applying data to a variety of resource and environmental problems and ordering data from EDC via remote computer terminals located at these facilities.

	EROS Applications Assistance Facility HQ Inter-American Geodetic Survey Headquarters Building Drawer 934 Fort Clayton, CZ	
USGS National Cartographic Information Center (NCIC)	National Cartographic Information Center U.S. Geological Survey 507 National Center, Room 1-C-107 12201 Sunrise Valley Dr. Reston, VA 22092 (703) 860-6045 Eastern National Cartographic Information Center U.S. Geological Survey 536 National Center 12201 Sunrise Valley Dr. Reston, VA 22092 (703) 860-6336 Mid-Continent NCIC U.S. Geological Survey P. O. Box 133 1400 Independence Road Rolla, MO 65401 (314) 364-3680 Rocky Mountain NCIC U.S. Geological Survey Box 25046, Federal Center Mail Stop 504 Denver, Colorado 80205 (303) 234-2326 Western NCIC U.S. Geological Survey 345 Middlefield Road Menlo Park, CA 94025 (415) 323-8111, ext. 2426	NCIC collects and organizes descriptive information about cartographic data from federal agencies, tells where they are located, ensures their availability and provides ordering assistance. NCIC also provides professional assistance in selecting and identifying the best cartographic data to solve a problem. The kinds of data which NCIC collects information on includes maps, charts, aerial and space imagery, geodetic control, digital data, cartographic publications and other survey data. NCIC also provides ordering assistance for aerial and satellite products available from the EROS Data Center.

National Space Technology
Laboratories NCIC
U.S. Geological Survey
Building 3101
NSTL Station, MS 39529
(601) 688-3544

Tennessee Valley Authority
NCIC
200 Haney Building
311 Brood Street
Chattanooga, TN 37401

APPENDIX A-2

Selected University Remote Sensing Programs or Laboratories

School	Remote sensing Facility/ Program	Area(s) of Major Applications
University of California	Remote Sensing Research Program School of Forestry and Conservation Berkeley, CA 97420	Forestry Agriculture Range management Water resources
Colorado State University	Engineering Research Center Foothills Campus Fort Collins, CO 80523	Multidisciplinary
Cornell University	College of Engineering Remote Sensing Program 464 Hollister Hall Ithaca, NY 14850	Multidisciplinary
Georgia Institue of Technology	Remote Sensing Unit Georgia Tech Engineering Experiment Station Electromagnetic Laboratory Electro-optics Division Atlanta, GA 30332	Multidisciplinary
University of Georgia	University of Georgia Department of Geography Athens, GA 30602	Multidisciplinary
University of Idaho	Geology Department Geophotography and Remote Sensing Center Mosco, ID 83843	Geology Hydrology
University of Kansas	Center for Research Remote Sensing Laboratory 2291 Irving Hill Drive Lawrence, KS 60645	Land Use Agriculture Soil moisture Microwave Analog and digital optical systems
Louisiana State University	Remote Sensing and Image Processing Laboratory Louisiana State University Baton Rouge, LA 70803	Multidisciplinary
University of Miami	Remote Sensing Laboratory P. O. Box 248003 Coral Gables, FL 33124	Meterology Oceanography Air and water pollution Water resources

University of Michigan	Remote Sensing Program University of Michigan Ann Arbor, MI 48194	Forestry Wildlife Insect and plant dise detection Land use Light reflection Energy flow modeling Geological prospectin Water quality Urban analysis
University of Minnesota	Remote Sensing Laboratory College of Forestry St. Paul, MN 55108	Forestry Range management Hydrology
Mississippi State University	Mississippi Remote Sensing Center P. O. Drawer FD Mississippi State, MS 39762	Multidisciplinary
Murray State University	Mid-America Remote Sensing Center Murray State University Murray, KY 42071	Multidisciplinary
University of Missouri at Columbia	University of Missouri at Columbia Geographic Resources Center 240 Electro Engineering Building Columbia, MO 65211	Multidisciplinary
University of Missouri at Rolla	Remote Sensing Laboratory Department of Geological Engineering University of Missouri - Rolla 125 Mining Building Rolla, MO 65401	Multidisciplinary
University of Nebraska	Remote Sensing Application Laboratory P. O. Box 688 Omaha, NE 68101	Land use and Wet lands analysis
University of New Mexico	Technology Applications Center Albuquerque, NM 87131	Multidisciplinary
North Carolina State University	North Carolina State University Department of Forestry P. O. Box 5488 Raleigh, NC 27650	Multidisciplinary
Oklahoma State University	Center for Application of Remote Sensing 405 Engineering South Stillwater, OK 74078	Multidisciplinary
University of Oklahoma	Department of Geography University of Oklahoma Norman, OK 73019	Multidisciplinary

Oregon State University University	Environmental Remote Sensing Applications Lab Corvallis, OR 97331	Multidisciplinary
Pennsylvania State University	Office for Remote Sensing of Earth Resources, Space Science and Engineering Laboratory 319 Electrical Engineering West University Park, PA 16802	Multidisciplinary
Purdue University	LARS 1220 Potter Drive Purdue University West Lafayette, IN 47907	Computer analysis techniques
University of South Carolina	University of South Carolina Computer Service Division 514 South Main Street Columbia, SC 29208	Multidisciplinary
South Dakota State University	Remote Sensing Institute Brookings, SD 57006	Multidisciplinary
Stanford University	Department of Applied Earth Science Remote Sensing Laboratory Stanford, CA 94305	Geology Soil types Computer techniques Geobotany
Middle Tennessee State University	Geobased Information System for Tennessee Old Main Building Middle Tennessee State University Murfreesboro, TN37130	Multidisciplinary
Texas A & M University	Remote Sensing Center Texas A & M University College Station, TX 77843	Multidisciplinary
University of Texas	University of Texas at Austin Department of Geography Austin, TX 78712	Multidisciplinary
University of Washington	Department of Urban Planning Remote Sensing Applications Laboratory Mail Stop JO-40 Seattle, WA 98195	Land occupancy Environmental mapping and analysis

APPENDIX A-3

State Remote Sensing Coordinators*

ALABAMA

Mr. Walter Stevenson
Plannning and Development Office
Office of the Governor
3734 Atlanta Highway
Montgomery, AL 36130

ALASKA

Mr. James R. Anderson
Department of Natural Resources
3001 Porcupine Drive
Anchorage, AK 99501

ARIZONA

Mr. Mike Castro
Information Resources Division
1624 West Adams
Phoenix, AZ 85007

ARKANSAS

Mr. William V. Bush
Geological Commission
Department of Commerce
3815 Roosevelt Road
Little Rock, AR 72204

CALIFORNIA

Mr. Timothy Hays
Office of Planning & Research
1400 - 10th Street, Room 156
Sacramento, CA 98514

COLORADO

Mr. Leonard Slosky
Governor's Office
136 State Capitol Building
Denver, Colorado 80203

DELAWARE

Mr. David L. Hardin
Department of Natural Resources
and Environmental Control
Box 1401
Dover, DE 19901

FLORIDA

Mr. William Kuyper
State Topographic Office
Department of Transportation
Haydon Burns Building
Tallahassee, FL 32304

GEORGIA

Mr. Bruce Rado
Environmental Protection Division
Resource Assessment Program
19 Martin Luther King, Jr., Drive
Southwest, Room 400
Atlanta, Georgia 30334

HAWAII

Mr. Shoji Kato
Department of Planning and Economic
Development
P.O. Box 2359
Honolulu, HI 96804

IDAHO

Mr. Kim Johnson
Department of Water Resources
373 West Franklin Street
Boise, Idaho 83720

*Connecticut and Rhode Island do not have contacts.

Appendix A-3 (continued)

ILLINOIS

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Institute of Natural Resources
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INDIANA

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Forest Resource Planner
State Planning Services Agency
143 West Market Street
Indianapolis, Indiana 46204

IOWA

Mr. Bernard Hoyer
Iowa Geological Survey
123 North Capitol
Iowa City, Iowa 52240

KANSAS

Dr. Ed Martinko
KARS Program
Space Technology Center
University of Kansas
Lawrence, KS 66045

KENTUCKY

Dr. Wally Dryden
Department of Natural Resources and
Environmental Protection
Capital Plaza Tower
Frankfort, KY 40601

LOUISIANA

Dr. Charles Harlow
Remote Sensing and Image Processing
Laboratory
3418 CEBA
Louisiana State University
Baton Rouge, LA 70803

MAINE

Mr. James Conners
Land Use Regulatory Commission
State House
Augusta, ME 04333

MARYLAND

Ms. Susan Alderman
Department of State Planning
301 West Preston Street
Baltimore, MD 21201

MASSACHUSETTS

Dr. Robert L. Huguenin
Remote Sensing Center
Blaisdell House
University of Massachusetts
Amherst, MA 01003

MICHIGAN

Mr. Larry Folks
Division of Land Resource Programs
Department of Natural Resources
Steven T. Mason Building
Lansing, MI 48909

MINNESOTA

Mr. Don Yaegar
State Planning Office
101 Capitol Square Building
550 Cedar Street
St. Paul, Minn. 55101

MISSISSIPPI

Mr. Paul E. Downing
Research and Development Center
P.O. Box 2470
Jackson, MS 39205

Appendix A-3 (continued)

MISSOURI

Dr. Chris Johannsen
Cooperative Extension Service
214 Waters Hall
University of Missouri
Columbia, MO 65201

MONTANA

Mr. Thomas Dundas
Department of Community Affairs
1424 9th Avenue
Helena, MT 59601

NEBRASKA

Dr. Rex Peterson
Remote Sensing Center
Institute of Agriculture and
Natural Resources
University of Nebraska
113 Nebraska Hall
Lincoln, NE 68588

NEVADA

Mr. Mike Nolan
State Planning Coordinator's Office
Capitol Building
Capitol Complex
Carson City, NV 89710

NEW HAMPSHIRE

Mr. James F. McLaughlin
Office of State Planning
2-1/2 Beacon Street
Concord, NH 03301

NEW JERSEY

Mr. Bob Mills
Bureau of Planning & Automated
Systems
Department of Environmental
Protection
88 East State Street
Trenton, New Jersey 08625

NEW MEXICO

Ms. Kate Wickers
Department of Natural Resources
Villagra Building
Snta Fe, NM 87503

NEW YORK

Mr. John C. Harmon
Department of Environmental
Conservation
50 Wolf Road
Albany, NY 12233

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Mr. Peter Lund
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P.O. Box 27687
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Appendix A-3 (continued)

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Remote Sensing Unit
Department of Natural Resources
Fountain Square
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Mr. Keith Vaughn
Water Quality Program
Oklahoma Conservation Division
20 State Capitol
Oklahoma City, OK 73105

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Department of Land Conservation
and Development
1175 Court Street, N.W.
Salem, OR 97301

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Mr. Gary Peterson
ORSER
220 Electrical Engineering, West
Pennsylvania State University
University Park, PA 16802

SOUTH CAROLINA

Mr. Gerald R. Minick
USC Computer Graphics
2712 Middleburg Drive, Suite 104
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SOUTH DAKOTA

Mr. Bill Ripple
State Planning Bureau
Capitol Building
Pierre, SD 57501

TENNESSEE

Mr. Sam Pearsall
Tennessee Heritage Program
Department of Conservation
2611 West End Avenue
Nashville, TN 37203

TEXAS

Mr. David Ferguson, Director
Information Systems and Services
Texas Department of Water Resources
P.O. Box 13087
Austin, TX 78711

UTAH

Ms. Martha Smith
Utah Geological Survey
606 Blackhawk Way
Salt Lake City, Utah 84108

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Mr. Dennis Malloy, Chief
Vermont Information Service
State Planning Office
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Monteplier, Vermont 05602

VIRGINIA

Mr. Warren Hypes
Langley Research Center
Code 325
Hampton, VA 23665

WASHINGTON

Mr. Michael J. McCormick
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Geological and Economic Survey
P.O. Box 879
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WISCONSIN

Ms. Brenda Hagman
Ecological and Environmental
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101 South Webster
Madison, WI 57302

WYOMING

Mr. Collin Fallat
Office of State Planning Coordinator
State Capitol
Cheyenne, WY 82002

APPENDIX B

Major Sources of Existing Aerial and Satellite Remote Sensing Data

B-1 -- Major Sources of Existing Aerial Photography

B-2 -- Major Satellite Sources of Remote Sensing Data

APPENDIX B-1

Major Sources of Existing Aerial Photography

Source	Description	Acquisition Procedures
FEDERAL SOURCES		
USGS Aerial Mapping Photography	Panchromatic (black-and-white) aerial photography periodically flown over entire U.S. for mapping purposes. Depending on the planned use of the photographs, the aerial survey altitude ranges from 600 to 12,000 m. The basic film format is 23 by 23 cm and shows areas from 4.8 to 14.4 km. The photography has less than 5 percent cloud cover.	Because of the large number of aerial photographs needed to show any specific region on the ground, the photographs have been indexed by mounting series of consecutive and adjacent overlapping specified areas. These aerial photographic mosaics are referred to as "photo indexes" and allow for rapid identification of photographic coverage of a specific area. Presently, some 50,000 photo indexes are available at the EROS Data Center (EDC) or the National Cartographic Information Center. When ordering aerial photography from these centers, it is necessary first to order a photo index of the area of interest to determine the specific aerial photographs needed.
NASA Aerial Photography	NASA aerial photography is available in black-and-white, color, or false-color infrared and clearly shows easily identifiable ground features such as roads, farms, and cities. Cloud cover is present in some photographs, and NASA aerial photographic coverage is not available for all areas. Products are available in a	NASA aerial photography should be ordered from EDC with the NASA Aircraft (Aerial) Photography Order Form. A careful study should be made of the geographic search computer listing. In most cases, NASA aerial photographs are accessed from the first and last frame numbers and the number of frames on the computer

Appendix B-1 (continued)

Source	Description	Acquisition Procedures
NASA Aerial Photography (continued)	wide variety of formats from flights at altitudes above 18,000 m. The high-altitude photography is generally available on a 23- by 23-cm film format at approximate scales of 1:120,000 and 1:60,000. In general, each high-altitude frame of 23-cm film format photography at 1:120,000 scale shows an area approximately 27 km square.	listing, However, if the geographic search is made on a geographic point, the computer will interpolate the strip and identify that photograph within the strip that best satisfies the request. In some cases, it is possible to obtain U-2 imagery directly from the NASA/Ames Research Center, Moffett Field, California 94035, (415) 965-6252 or FTS 448-6252.
U. S. Department of Agriculture, Agriculture Stabilization and Conservation Service (ASCS), and Soil Conservation Service (SCS) Publications	ASCS has panchromatic coverage of approximately 80 percent of the land area of the U.S. including Hawaii. No coverage is available for Alaska. Color infrared corn-blight photography coverage is available for the major corn growing regions of the U.S. (primarily in the Midwestern States). Panchromatic coverage is updated about every 7 years. Initial photography was flown at a scale of 1:20,000. More recently the scale used has been 1:40,000.	Obtain latest ASCS publications "Aerial Photography Status Maps" and "Aerial Photography Coverage" from ASCS, Aerial Photography Field Office, 2511 Parley's Way, Salt Lake City, Utah 89109. "Aerial Photography Status Maps shows the latest photographic coverage available for each state and county. "Aerial Photography Coverage" is a listing by state and county of the various coverages (dating back to 1942) obtained by ASCS and its predecessors. The year of phtography and number of photo indexes for each county are shown. Also request ASCS Form 441 (order for aerial photographs).
Geographical/Regional Data Collections (Corps of Engineers, U.S. Forest Service Bureau of Land Management, Bureau of	Many Federal agencies have extensive regional collections of remote sensing imagery that are available for purchase or loan from the collecting regional/district organiza-	

Appendix B-1 (continued)

Source	Description	Acquisition Procedures
Reclamation, National Oceanic and Atmospheric Administration, TVA, Defense Intelligence Agency, etc.).	tion acquiring the imagery.	
Site-Specific Collections of the Environmental Protection Agency (EPA)	The EPA has an expanding imagery collection for specific areas throughout the U.S. having environmental related problems. Scale: 1:2,000 to 1:80,000 (average 1: 8,400); format size: 241 mm and 127 mm; cloud cover: 10 percent or less; film types: color and color infrared.	All imagery from contracted aerial flights and other sources (e.g., U.S. Air Force) are held at the Environmental Photo Information Center and are available for loan to other Federal agencies. For information on existing imagery holdings, inquiries should be made directly to: Environmental Photo Information Center P.O. Box 1587 Vint Hill Farms Warrenton, Virginia 22186
STATE GOVERNMENT SOURCES		
State, Highway, Environmental, Natural Resource Departments, Planning Offices and Geological Surveys	Most all states have collections of large scale, black-and-white aerial imagery and to a lesser extent collections of color, color infrared, and thermal imagery that are available for loan and/or purchase.	Aerial imagery collected by state agencies can be obtained by directly contacting agencies involved even though in many cases imagery is available from contractors acquiring the imagery. State remote sensing coordinators (Appendix A-3) may be helpful in locating imagery.

Appendix B-1 (continued)

Source	Description	Acquisition Procedures
COMMERCIAL SOURCES		
Aerial Survey and Mapping Companies	Most private organizations which provide aerial data acquisition services have negatives and can make prints of areas they have flown.	Major commercial organizations providing aerial acquisition services which are potential sources for existing imagery are listed in the Remote Sensing Industry Directory which accompanies this technical guide.

Address List

ALL FEDERAL SERVICES

National Cartographic Information Center[a]
U.S. Geological Survey
National Center, Stop 507
Reston, VA 22092

User Services Unit
EROS Data Center
U.S. Geological Survey
Sioux Falls, SD 57198

AGRICULTURE

Agriculture Stabilization and Conservation Service
Aerial Photography Field Office USDA-ASCS
Administratrive Services Division
Salt Lake City, Utah 89109

U.S. Forest Service, USDA
Engineering Staff Unit
Washington, D.C. 20250

Soil Conservation Service, USDA
Cartographic Division
Federal Building
Hyattsville, Maryland 20784

[a]Although headquartered in Reston Virginia, the National Cartographic Information Center (NCIC) maintains regional offices at each USGS Mapping Center in Virginia, Missouri, Colorado, and California and at the National Space Technology Laboratories in Mississippi. NCIC has also established affiliated offices in several states. These offices have subsets of the various information bases and computer links with EDC and can assist users in obtaining relevant aerial photography and/or map products.

Appendix B-1 (continued)

Address List (continued)

NASA

Earth Resources Aircraft Project
Room 280, Building 211-12
NASA/Ames Research Center
Moffett Field, CA 94035

NATIONAL OCEAN SURVEY

National Oceanic and Atmospheric Administration
National Oceanographic Data Center
Page Building 1
2001 Wisconsin Avenue, N.W.
Washington, D.C. 20235

TVA

Tennessee Valley Authority
Maps and Surveys Branch
200 Haney Building
311 Broad Street
Chattanooga, Tenn. 37401

EPA

Environmental Photo Interpretation Center
P.O. Box 1587
Vint Hill Farms
Warrenton, VA 22186

SOURCE: Department of the Army Office of Chief of Engineers, Remote Sensing Applications Guide, Washington, D.C. 1980.

APPENDIX B-2

Major Satellite Sources of Remote Sensing Data

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Automated Satellites	
Landsat 1, 2 Launch date: 1972, 1975 Character: Prototype	4-Band multispectral scanner, visible near infrared (MSS) Spatial Res.= 80 m	0.5 to 0.6 m 0.6 to 0.7 m 0.7 to 0.8 m 0.8 to 1.1 m	Landsat data are archived by the USGS at the EROS Data Center in Sioux Falls, SD, and may be purchased in either photographic or digital tape form (MSS only). Landsat 1 coverage extends from July 1972 through January 1978, when the platform was deactivated. Problems were experienced in the RBV system on board this satellite early in the mission. Consequently, very little RBV data are available. Later in the Landsat 1 mission (March 1977), data loss was experienced with the 0.5- to 0.6- m band of the MSS system. Landsat 2 coverage began in January 1975 and is still being received at the time of this writing (1979). The MSS and RBV sensors on Landsat 2 are both operational, but the RBV system is used only on a limited basis.
	3-Camera, return beam vidicon, visible near infrared (RBV) Spatial Res.= 80 m	0.437 to 0.575 m 0.580 to 0.680 m 0.690 to 0.830 m	

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Automated Satellites	
Landsat 3 Launch date: 1978 Character: Prototype	5-Band, multispectral scanner, visible thermal infrared (MSS-3); Spatial Res.= 80 m, 200 m	Same as Landsat 1,2 10.4 to 12.6 m	The MSS system on board Landsat 3 is identical with those of its predecessors with the exception that a lower resolution thermal infrared band was added. No data are being collected with the Landsat 3 thermal infrared system since it malfunctioned in August 1978. Also, the RBV system on the new satellite has been changed from a three-band multispectral sensor system to a higher resolution, two-camera, panchromatic configuration. Indications are that the new RBV system appears to be working very well, while the utility of the data from the thermal infrared band is questionable. NASA is publishing a series of manuals, which will be available in 1979, describing how to use Landsat data.
	2-Camera, return beam vidicon, panchromatic (REV-3) Spatial Res.= 40 m	0.505 to 0.750 m	

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Automated Satellites	
NOAA 4, 5 Launch date: 1975, 1976 Character: Operational	Very high-resolution radiometer, visible, thermal infrared (VHRR) Spatial Res.= 1 km	0.5 to 0.7 m 10.5 to 12.5 m	The relatively low resolution of VHRR limits its use primarily to assessments of large regional features. However, often this synoptic view can reveal features that are obscured by the detail contained in higher resolution imagery such as geological features. Digital image data produced by the VHRR system of the NOAA satellite series are stored on a 90-day rotation basis by the Satellite Data Services Branch of the National Oceanic and Atmospheric Administration (NOAA). When digital tapes of any selected orbital path are desired, they must be purchased within 90 days of the date of acquisition, or the master tapes will have been recycled. Photographic products are maintained on a more permanent basis. NOAA 4, which ceased operation in 1976, and NOAA 5, which ceased operation in early 1978, were the last in a series of satellites that have been replaced by recent TIROS 14 series.
TIROS 14 Launch date: 1978 Character: Operational	Advanced very high-resolution radiometer, visible, thermal infrared (AVHRR); Spatial Res.= 1km	0.5 to 0.7 m 10.5 to 12.5 m	

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Automated Satellites	
NIMBUS 7 Launch date: 1978 Character: Operational	6-Band, multispectral coastal zone color scanner, visible, thermal infrared (CZCS) Spatial Res.= 800 m	0.433 to 0.453 m 0.510 to 0.530 m 0.540 to 0.560 m 0.660 to 0.680 m 0.700 to 0.800 m 10.5 to 12.5 m	CZCS is the first sensor specifically devoted to ocean color measurements. It is a multispectral scanner designed to study processes in coastal zones by remote sensing of both color and temperature. The instrument is not intended to operate continuously, but only on command. Data from the CZCS, processed to calibrated radiance or equivalent blackbody temperature, will be available on an unrestricted basis after initial validation is accomplished, but only for limited areas because of spacecraft power limitations. For more information about data availability contact the Environmental Data Service of NOAA.

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Automated Satellites	
Seasat 1 Launch date: 1978 (06/26/78-10/10'78) Character: Experimental	Synthetic aperture radar (SAR) Spatial Res.= 25 m	1.4 GHz	The Seasat 1 mission lasted less than 4 months, and only representative data were collected. The sensor of primary interest on the Seasat 1 platform was the Synthetic Aperture Radar (SAR) system. The most attractive feature of this device was its high resolution. For Seasat 1, SAR data acquired over coastal areas during its operational lifetime, Corps users should contact NOAA's Environmental Data Service or the Jet Propulsion laboratory.
Heat Capacity Mapping Mission(HCMM). Also called Applications Explorer Mission 1 Launch date: 1978 Character: Experimental	Heat capacity mapping radiometer, 2-Band thermal infrared scanning system (HCMR) Spatial Res.= 500 by 500 m, 0.5° temperature resolution	10.5 to 12.5 m 0.5 to 1.1 m	Differences in radiant temperature can be determined from day and night thermal infrared images. These data can be combined with albedo information from the photographic band to calculate thermal inertia of surface materials. Data are being evaluated for discriminating rock types and mineral resource location, measuring soil moisture, mapping thermal effluents, and monitoring snow fields for water runoff predictions.

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Manned Satellites	
Gemini & Apollo Launch date: 1965-1969	Handheld 70-mm camera and array of four hasselblads Spatial Res.= varies, all very small scale	Black-and-white and color photographs, first multiband orbital photography	Orbital photography of the earth acquired during ten Gemini and two Apollo flights during 1965-1969. Close to 4000 black-and-white, color, and multiband photographs of the earth's surface of usable quality are available from the EROS Data Center.
Skylab Launch date: 1973-1974	6-Camera, multispectral array, visible to near infrared (S190A) Spatial Res.= 70 m	0.5 to 0.6 m 0.6 to 0.7 m 0.7 to 0.8 m 0.8 to 0.9 m 0.5 to 0.88 m 0.4 to 0.7 m	The Earth Resources Experiment Package on the three manned Skylab missions produced some high-quality multispectral photographic images for selected portions of the earth's surface between 50° North latitude and 50° South latitude. The multispectral images produced by the S190A camera array have almost the same resolution as the Landsat data. Less in quantity but generally more useful are the color and color infrared photographs acquired with the S190B earth terrain camera. All Skylab photographic data are available from the EROS Data Center.
	High-resolution earth terrain camera, panchromatic (S190B) Spatial Res.= 25 to 35 m	Variable	

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
	Future Systems		
Landsat D Launch date: 09/30/81	Thematic mapper scanner (TM) 7 spectral bands Spatial res.= 30 m (for first six, reflective bands) Spatial res.=120 m (for 7th band, thermal)	0.45 to 0.52 m 0.52 to 0.60 m 0.63 to 0.69 m 0.76 to 0.90 m 1.55 to 1.75 m 10.40 to 12.50 m 7th band to be determined	Landsat D is to provide extended spectral coverage and improved spatial resolution of the type required to meet many user applications. Also, by using communications satellite relay (Domsat) data delivery to the end user will be reduced to several days. Landsat D will be the first NASA spacecraft that is shuttle-compatible and can be retrieved, refurbished, and reflown. This satellite should have a major impact on the development of operational Landsat data users.
	4-Band Multispectral scanner (MSS-3)	Same as Landsat 3	
Landsat E	Same as Landsat D	Same as Landsat D	If Landsat D is successful, the backup spacecraft will be shuttlelaunched as Landsat E. The two spacecraft would then be alternated in orbit to serve as an operational earth observation system.
Space Shuttle Launch date: 1980's (first manned orbital flight scheduled November 1979)	Various imaging systems including cameras, scanners, and radar		Reusable shuttle vehicles will carry crews and imaging systems into orbit and return. The shuttle will also serve as a stage for launching small unmanned satellites with imaging systems and for servicing and repairing other satellites such as Landsat D.

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Future Systems	
Orbital Flight Test (OFT 2, 6) Launch date: 1984	Shuttle multispectral infrared radiometer (SMIRR)	10-channel near infrared (non-imaging)	The first six shuttle missions are called Orbital Flight Tests (OFT). These flights are basically to test the shuttle systems, but two tests have been assigned to NASA's Office of Space and Terrestrial Applications to develop experimental earth resources programs. OFT 2 is to carry an instrumented pallet, and OFT 6 is to test the independent spacecraft launch and retrieval system.
	Ocean color scanner (OCS); Spatial Res.= Low resolution images	10-channel visible spectrum	
	Shuttle imaging radar (SIR)	Modified Seasat 1 radar to 50^{o} look angle for terrain studies	
	Large format camera (LFC); Spatial Res.= 15 to 20 m	Color, color infrared, and panchromatic images Scale: 1:1,000,000 Stereo: 80 percent operational overlap Focal length 30 cm	The LFC will provide wide-angle synoptic coverage at high spatial resolution with color and color infrared capability and optional stereo geometry. It has been designed for geologic/exploration type uses.

Appendix B-2 (continued)

Spacecraft	Sensors of Interest	Sensor Operating Wavelength or Frequency	Comments
		Future Systems	
Stereosat	Return beam vidicon system will acquire images in a single visible band Spatial Res.= 19.3 by 16.6 m	2- to 600-mm focal length telephoto lens set at stereo angle of 45° or 60° using linear arrays; swath width of 31 km	Specialized satellite requested by the geological industry to acquire high-resolution satellite imagery for stereo viewing.
National Oceanic Satellite system (NOSS)	Modified Seasat 1 radar		Joint DOE, NOAA and NASA system using microwave instruments similar to Seasat 1 SAR to provide all-weather, high-resolution imagery capability.
Synchronous Earth Observation Satellite (SEOS)	1.8-m telescope in 4 spectral bands Spatial Res.= 600 m	Continuous scan	Study stage only--not an approved NASA program as of January 1979.
Launch date: Late 1980's	Spatial Res.=16 to 60 m	Fine scan	

SOURCE: Department of the Army Office, Chief of Engineers, Remote Sensing Applications Guide, Washington, D.C., 1979. (EP-70-1-1)